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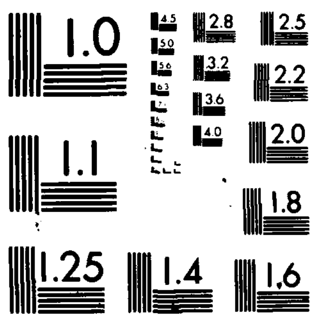
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Technical Note

CEL

TN no. N-1584

title: DECEL1 USERS MANUAL-A FORTRAN IV PROGRAM FOR COMPUTING THE STATIC DEFLECTIONS OF STRUCTURAL CABLE ARRAYS

author: S. Sergev

date: August 1980

sponsor: Naval Facilities Engineering Command

program nos: YF59.556.091.01.402

CIVIL ENGINEERING LABORATORY
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Port Hueneme, California 93043

80 12 16 027

(1) Final rept. Jun 79-Jul 80,

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

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REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER CEL ~~TN-1584~~	2. GOVT ACCESSION NO. AD-A093 356	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) (6) DECEL1 USERS MANUAL, A FORTRAN IV PROGRAM FOR COMPUTING THE STATIC DEFLECTIONS OF STRUCTURAL CABLE ARRAYS.		5. TYPE OF REPORT & PERIOD COVERED Final; Jun 1979 – July 1980
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) (10) S. Sergev		8. CONTRACT OR GRANT NUMBER(s) (16) F59
9. PERFORMING ORGANIZATION NAME AND ADDRESS Civil Engineering Laboratory Naval Construction Battalion Center Port Hueneme, California 93043	(17)	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 62759N; YF59.556.091.01.402
11. CONTROLLING OFFICE NAME AND ADDRESS Naval Facilities Engineering Command Alexandria, Virginia 22332	(11)	12. REPORT DATE August 1980 (12) 200 13. NUMBER OF PAGES 194
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		15. SECURITY CLASS. (of this report) Unclassified 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Cables, cable dynamics, cable statics, oceanic cables

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

DECEL1 is a Fortran IV program for computing the ocean current-induced static deflections of undersea structural cable arrays. As dimensioned, the program can handle arbitrarily configured arrays of up to 22 cables. The cables can be electromechanical, wire rope, or synthetic. Any number of discrete devices (buoyancy elements, current meters, tensiometers, etc.) can be incorporated in the array. An option for parametric studies is included in the program, as is an option for incorporating arbitrary current fields. As

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DECEL1 USERS MANUAL – A FORTRAN IV PROGRAM FOR COMPUTING THE STATIC DEFLECTIONS OF STRUCTURAL CABLE ARRAYS (Final), by S. Sergev
TN-1584 194 pp illus August 1980 Unclassified

1. Cables 2. Oceanic cables I. YF59.556.091.01.402

DECEL1 is a Fortran IV program for computing the ocean current-induced static deflections of undersea structural cable arrays. As dimensioned, the program can handle arbitrarily configured arrays of up to 22 cables. The cables can be electromechanical, wire rope, or synthetic. Any number of discrete devices (buoyancy elements, current meters, tensiometers, etc.) can be incorporated in the array. An option for parametric studies is included in the program, as is an option for incorporating arbitrary current fields. As written, DECEL1 should be compilable on most Fortran IV compilers with Boolean algebra capabilities.

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PREFACE

The Civil Engineering Laboratory (CEL), under sponsorship of the Naval Facilities Engineering Command, is engaged in a program of developing numerical tools for analyzing cable systems. As part of this work the NRL-written DESADE program has been used. In the course of using DESADE several improvements and additions have been made. The modifications are for the most part minor and serve to increase the accuracy of the mathematical modeling and to add user conveniences.

This report documents these modifications in the form of a revised users manual. (Much of the text of the original manual is used without modification.) To distinguish the updated program from the original NRL version, the program has been renamed DECEL1 for DESADE, CEL version one.

CEL's modifications were in five general areas:

1. Force calculations
2. Current field definition
3. Plotting options
4. Miscellaneous user conveniences
5. Iteration control

Force Calculations

Drag force and weight of cable sections covered by in-line devices have been deleted. (This assumes an in-line device that terminates the cable at each end of the device; floats that are in-line and envelope the cable must have their buoyancy adjusted by the weight of the enveloped cable segment.) This addition has a relatively minor effect except when in-line devices envelope a significant portion of a cable.

Calculation of tangential drag has been added to both cables and in-line devices.

Current Field Definition

The capability to accept a current field defined by 2, 3 or 4 current meter strings of up to 25 meters each has been added. Since much current meter data is referenced to magnetic north, the cable structure can be referenced to the current field by specifying the angle between the structure's X-axis and magnetic north.

The specification of current direction has been changed to be consistent with oceanographic terminology: a 90° current flows due east.

An option has been added to specify the input current velocity units; all velocities within an NDAT case must be the same units.

Plotting Options

Options have been added to plot the current field defined by two or more current meter strings and to plot the cable structure in either its deformed or undeformed configuration. Perspective or plan or elevation views can be depicted.

Miscellaneous User Conveniences

Required title cards have been added for the cable structure source deck and for each parametric case.

The specification of indexed and unindexed devices has been simplified. User selected devices now are automatically indexed, in order, by their location along a cable.

The changes allowed in a parametric study deck are such that the physical appearance of the array could be altered in the parametric case so much that referencing displacements to the original no-current case is illogical. An option has been added to declare any parametric case as the new no-current reference case. Displacements are printed referenced to both the original no-current case and to the present parametric reference case. The reference parametric case can be redefined any number of times since the original no current case is retained for the duration of the problem.

The error detection and display scheme has been altered. Errors that are detected by DECEL1 cause the entire input deck to be listed. Then, the cards with errors are flagged with a coded error number. The coded error message text is printed below the input card listing. All cards are scanned for errors; however, only the first error on a particular card is detected. The error messages are identical to those in the original DESADE manual except that only the portion of the message applicable to the card type is printed.

In some cases it is desirable to be able to punch on cards the locations of particular devices for input to other programs. An option has been added to select, based on device weight, the devices whose location is to be punched.

Iteration Control

Under some circumstances that have not been well defined, DECEL1 may either fail to converge or converge very slowly. To protect the user from high execution costs, iteration limits have been imposed. Iterative techniques are used to satisfy the imaginary reaction displacement constraints and to obtain the structure shape. Both iteration processes have had limits imposed because both have been the cause of excessively high execution costs.

These modifications have added to the capabilities of DECEL1 and have made it a more useful tool for the cable structure analyst.

INTRODUCTION

DECEL1 is a Fortran IV program for computing the ocean current-induced static deflections of undersea structural cable arrays. The solution algorithm is the Method of Imaginary Reactions (Refs 1,2)

combined with the method of successive approximations for treating position and configuration dependent forces (Refs 3,4).

As dimensioned, the program can handle arbitrarily configured arrays of up to 22 cables. The cables can be electromechanical, wire rope, or synthetic. Any number of discrete devices (buoyancy elements, current meters, tensiometers, etc.) may be incorporated in the array.

Certain limitations are placed on the structural characteristics of the arrays which can be analyzed by this program. These limitations are as follows:

1. No cables or cable segments may lie on the ocean floor. (No surface or bottom interaction is modeled, thus a cable may hang below the lowest anchor point.)
2. The dimensions of each discrete device must be small compared to overall array dimensions. Thus, for example, the application of this program to the analysis of an anchorage for a submerged submarine is not valid.
3. All parts of the array must be submerged. Thus, an array containing a surface buoy cannot be validly analyzed using this program. (The reason for this is that a surface buoy generates only one geometric constraint on its location.) An exception occurs when all three coordinates of a device on the surface can be specified - for example, the coordinates of a ship handling a crown line.

Also, certain hydromechanical assumptions are incorporated in the program as written. These are as follows:

1. The only hydrodynamic force considered to be acting on the discrete <u>devices</u> is a drag force. For in-line devices a normal drag coefficient and a tangential drag coefficient can be specified. For a free device, only the normal drag coefficient is to be specified. Lift forces are neglected as being small compared to the weight, buoyancy, and drag forces on these devices.
2. The only hydrodynamic force considered to be acting on the <u>cable</u> is a drag force. This drag force consists of both normal and tangential components and consequently two drag coefficients (normal and tangential) are to be specified for each cable.
3. The current option 1 is depth dependent in magnitude, unidirectional and horizontal. The current option 2 permits direction and magnitude variation as a function of depth. The current option 3 also permits magnitude and direction variation as a function of depth. This option requires two, three or four "strings" of depth dependent velocity data (where the strings are located at arbitrary points). These velocity data are used within the code via interpolation or extrapolation to obtain the velocity at any arbitrary point in space. In all cases the vertical component of velocity is assumed to be zero.

An option for parametric studies (changes in weights, diameters, cable lengths, anchor locations, etc.) is included in the program. DECEL1 also contains a series of error checks which insure that all input data are properly formulated.

Perspective plotting package SSP has been incorporated into DECEL1 to plot the deformed and/or undeformed configuration of the array.

The program uses the internally generated nodal points of the cables as the points to be plotted.

Scratch files 3, 4 and 10 must be available for use in the plotting package SSP.

Computer Requirements

As written, DECEL1 should be compilable on most Fortran IV compilers with Boolean algebra capabilities. Memory requirements for the program are approximately 206,000 (octal) words in single precision. Access to one, two, or three magnetic tape units, depending on the I/O options chosen, is required by the program.

Program Operation

The overall operation of the program DECEL1 is shown in the flow diagram in Figure 1. Numerical examples in Appendix A and the source language listing of the program is given in Appendix B.

Array Description

Typical cable arrays which can be analyzed using DECEL1 are shown in Figures 2a-2d. The figures also show the numbering and coordinate system conventions required for transmitting the array geometry to DECEL1. These conventions are as follows:

1. The cables comprising the array must be numbered consecutively from one to the total number of cables in the array (C1, C2, ... in Figure 2). Each cable so designated must have uniform properties (weight, drag coefficients, diameter, and constitutive relation) along its length. A change in property also requires a change in cable number as illustrated in Figure 2a.
2. The termination points of the cables in the array are called junctions. A junction may designate an anchor, the intersection point of two or more cables, or the free end of a cable such as illustrated by junction J9 in Figure 2c. The junctions must also be numbered consecutively from one to the total number of junctions in the array (J1, J2, ... in Figure 2).
3. A fixed, right-handed (X, Y, Z) Cartesian coordinate system must be chosen to describe the configuration of the array in space. This coordinate system is called the array-referenced coordinate system. The origin of the coordinate system can be arbitrarily located. The Z axis must be defined parallel to the direction of gravity and increasing upward. All distances are measured in feet.

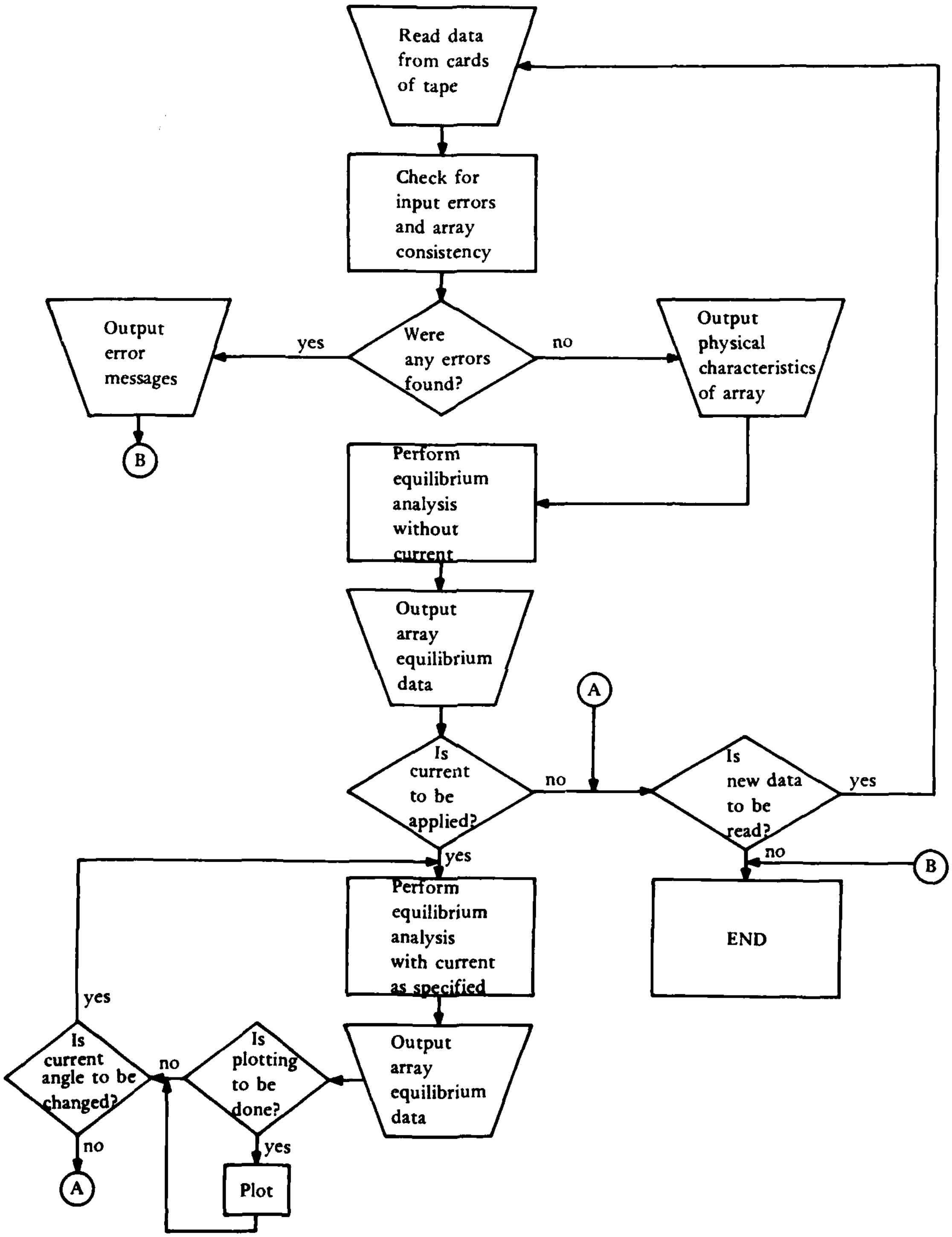


Figure 1. Generalized flow diagram of DECEL1 operation.

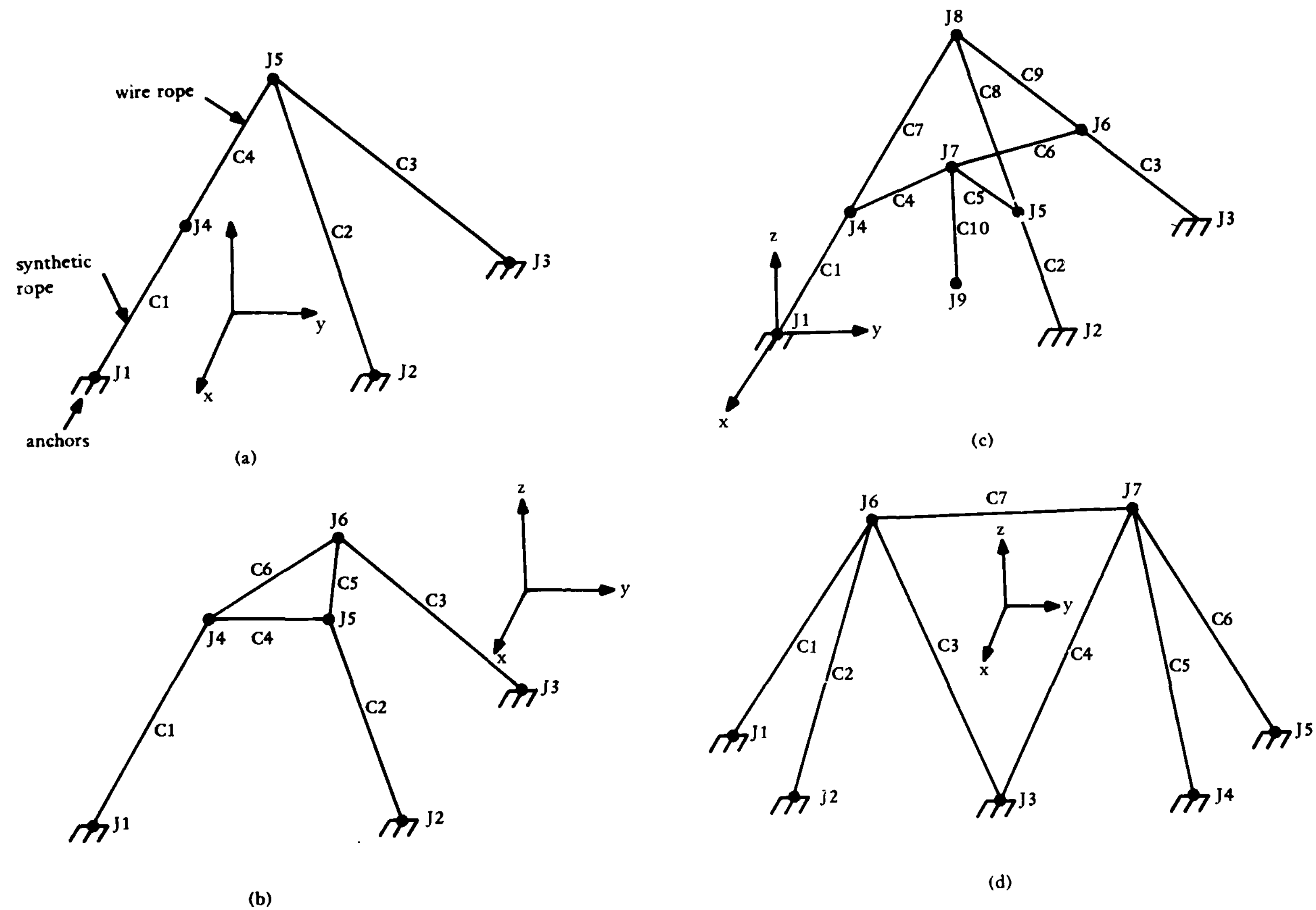


Figure 2. Typical cable arrays which can be analyzed using DECEL1.

4. The junction numbers corresponding to anchors and the coordinate of the anchors must be tabulated according to the scheme illustrated in Table 1.

Table 1. Anchor Tabulation

Column 1	Column 2	Column 3	Column 4
Junction number of Anchor	X coordinate (ft)	Y coordinate (ft)	Z coordinate (ft)

Anchors are defined to be any fixed end point of a cable; thus an "anchor" can be placed on the bottom or at the surface or anywhere within the water column.

Reduction to a Statically Determinate Array

Before an arbitrary cable array can be analyzed by DECEL1, a sufficient number of cuts must be made in the array to reduce it to a statically determinate structure. The effects of the constraints removed by these cuts are replaced by imaginary and equilibrating reactions (Refs 1,2).

The number of cuts required to reduce a cable array to a statically determinate structure is determined uniquely from the relation

$$\text{number of cuts} = \text{number of cables} + \text{number of anchors} - \text{number of junctions} \tag{1}$$

Certain rules must be adhered to as the required cuts are made. These rules are as follows:

1. All required cuts must be made at points directly adjacent to array junctions - that is at end points of the cables comprising the array.
2. The first group of cuts must be made so as to release all but one cable from an anchor.
3. The remaining cuts (if required) are made within the array structure and must be located so as not to break the array into two (or more) parts.
4. As cuts are made, each new cut must be assigned a consecutive junction number, continuing from the last-used junction number. Also, the junction number (in the original array) at which the cut is made must be tabulated.

In effect, applying rules 1-3 reduces the array to the equivalent of a topological tree. As the name implies, this is a continuous structure containing only one fixed point and for which a unique (nonduplicative) path exists from any point to any other point.

Examples of proper reductions to statically determinate structures for the arrays illustrated in Figures 2a-2d are shown in Figures 3a-3d, respectively. In each of these figures, the left-hand schematic shows the reduced array while the right-hand schematic depicts the topological tree representation of the reduced array. The information required by rule 4, which represents geometric constraints on the reduced array, is tabulated below the left-hand schematic in each figure.

Finally, it is necessary to define directions of increasing arc length along the cables comprising the array. The tree representation of the reduced array is used primarily for this purpose. These directions, indicated by the arrowheads in the right-hand schematic of each figure, are identified by starting from the base of the tree and climbing "up" the tree.

Let the measure of arc length along a cable be denoted by s which increases from zero to the total length of the cable L. Then, the required information on increasing directions of arc length can be summarized in terms of array junctions as shown in the table below the right-hand schematic in each figure.

Once an array has been reduced to the state represented by Figure 3, it is amenable to analysis by the program DECEL1.

Coordinate Systems

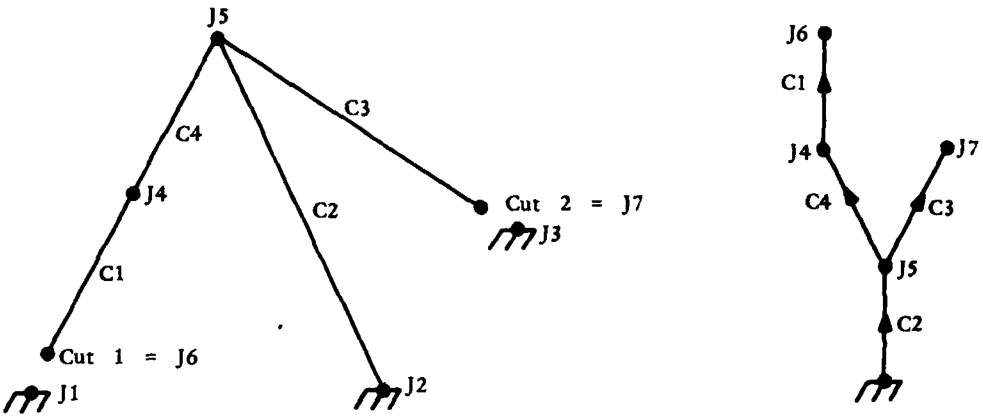
There are two coordinate systems used for inputting the data to DECEL1. They are the magnetically aligned reference coordinate system (N, W, Z) and the array or laboratory reference coordinate system (X, Y, Z). The two coordinate systems share the same origin and the same Z-axis; Z is positive upward. Consequently, the two coordinate systems can differ from one another by an arbitrary angular rotation in the horizontal plane which is denoted by ϕ. For arbitrary locations on the earth, the magnetic axes N-S and E-W are preestablished. Consequently, the angular rotation of the array-referenced coordinate system is referenced to the magnetic axes. In particular, ϕ is the angle between the N-axis and the positive X-axis. A positive rotation of the X-axis with respect to the N-axis is in the clockwise sense. Figure 4 illustrates the two coordinate systems.

The direction of positive rotation is in the clockwise sense in the magnetically aligned coordinate system. The zero degree reference is taken as the N-axis.

All current data to be input into the program are to be referenced with respect to the magnetic coordinate system. For example, a current having an inclination of 0° is flowing due north; a current with 270° inclination is flowing due west.

When current field input option 3 is selected, it is necessary to specify the locations on the ocean surface (horizontal plane) of the stations where current data have been gathered (relative to the N,W,Z coordinate origin). Typical examples of locations of such stations might be:

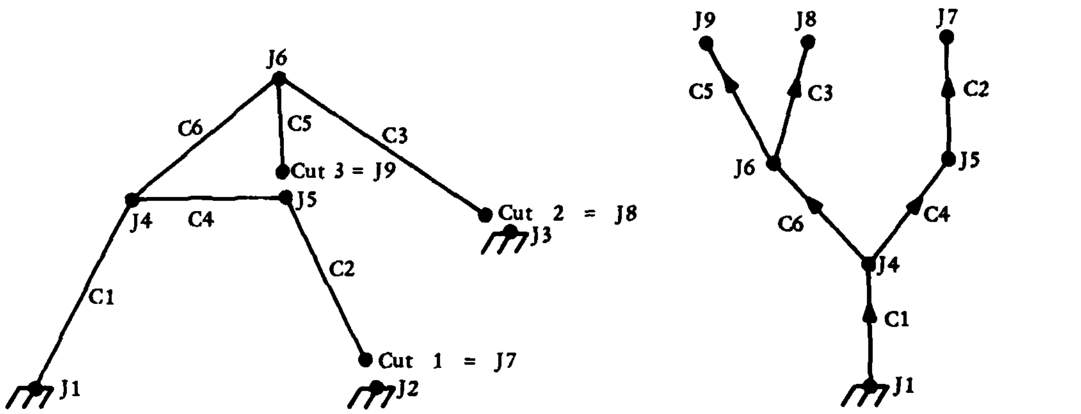
100 ft N by 3000 ft W	=	(100, 3000)
700 ft S by 1500 ft E	=	(-700, -1500)
0 ft N by 800 ft E	=	(0, -800)
400 ft N by 450 ft W	=	(400, 450)



Cut No.	Junction No. Assigned To Cut	Junction No. At Which Cut Made
1	6	1
2	7	3

Cable No.	Junction No. At s = 0	Junction No. At s = L
1	4	6
2	2	5
3	5	7
4	5	4

(a)

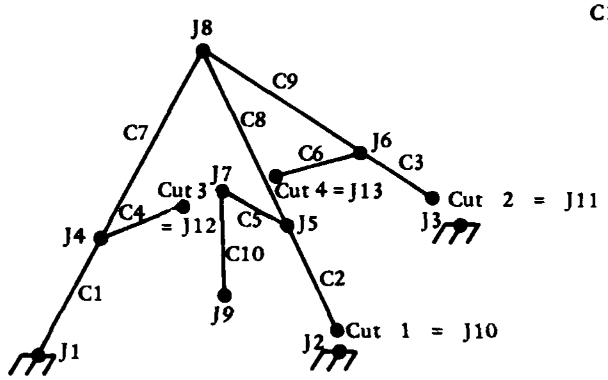


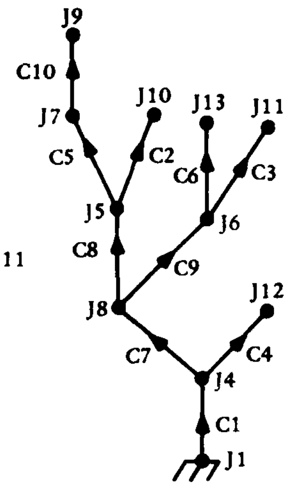
Cut No.	Junction No. Assigned To Cut	Junction No. At Which Cut Made
1	7	2
2	8	3
3	9	5

Cable No.	Junction No. At s = 0	Junction No. At s = L
1	1	4
2	5	7
3	6	8
4	4	5
5	6	9
6	4	6

(b)

Figure 3. Examples of proper reductions to statically determinate structures for the arrays shown in Figures 2a and 2b.

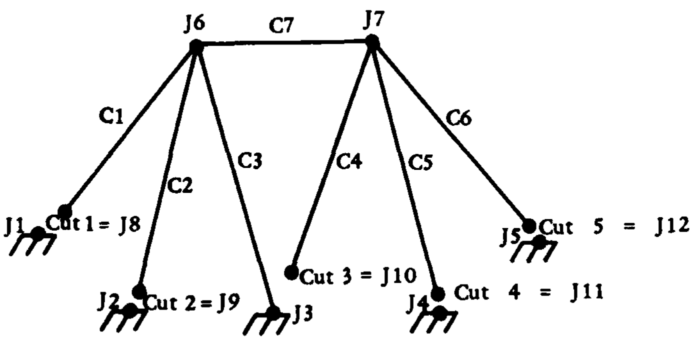


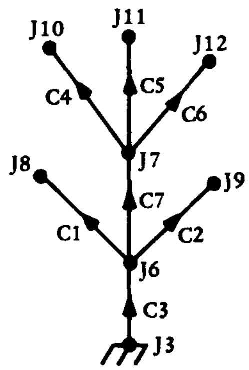


Cut No.	Junction No. Assigned To Cut	Junction No. At Which Cut Made
1	10	2
2	11	3
3	12	7
4	13	7

Cable No.	Junction No. At s = 0	Junction No. At s = L
1	1	4
2	5	10
3	6	11
4	4	12
5	5	7
6	6	13
7	4	8
8	8	5
9	8	6
10	7	9

(c)



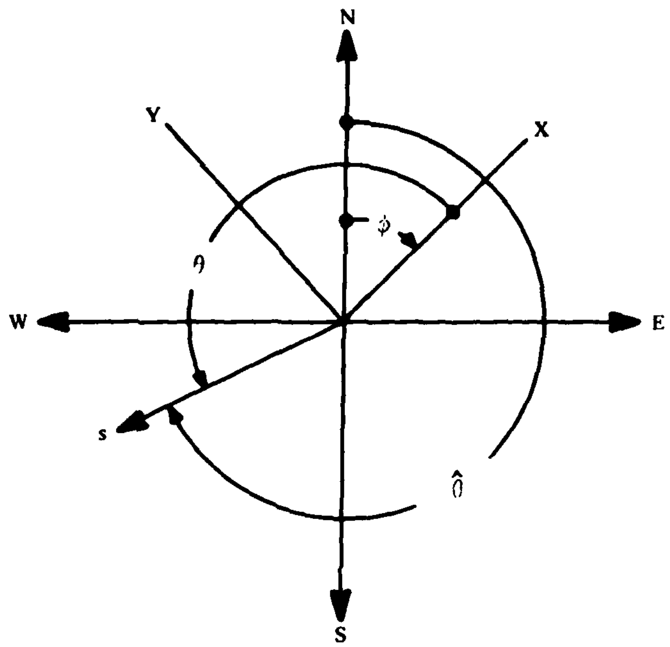


Cut No.	Junction No. Assigned To Cut	Junction No. At Which Cut Made
1	8	1
2	9	2
3	10	3
4	11	4
5	12	5

Cable No.	Junction No. At s = 0	Junction No. At s = L
1	6	8
2	6	9
3	3	6
4	7	10
5	7	11
6	7	12
7	6	7

(d)

Figure 3. Examples of proper reductions to statically determinate structures for the arrays shown in Figures 2c and 2d.



$$s = \sqrt{N^2 + W^2} \qquad X = s \cos \theta$$

$$\theta = 360 + \phi - \hat{\theta} \qquad Y = s \sin \theta$$

In the magnetic coordinate system the N,W axes are positive. (N,W) form a coordinate pair of a right handed coordinate system. The positive direction of rotation $\hat{\theta}$ in the (N,W) *coordinate system* is clockwise with the zero degree reference being the N - axis. The array coordinate system (X,Y) system. The relationship between the two systems is given above.

Figure 4. Description and relationship between the magnetic and array referenced coordinate systems.

Above (on the right), is an example of how such locations should be interpreted for input preparation as coordinate pairs. Note that the north-west quadrant is the first quadrant of a right-handed coordinate system. Consequently, north and west are positive axes while south and east are the negative axes. When current field input option 3 is selected, the current data are printed out in both the magnetic and array-referenced coordinate systems.

The specification of the anchor locations is accomplished with respect to the array-referenced (X, Y, Z) coordinate system. All internal calculations within DECEL1 are performed with respect to the array-referenced coordinate system. The (X, Y, Z) coordinate system is also right-handed. In the horizontal plane in this frame of reference the direction of positive rotation is counter-clockwise with the positive X-axis being the zero degree reference.

Directions of Positive Rotation

Reference System	0° Reference	Positive Rotation
Magnetic	N-axis	clockwise
Array	X-axis	counter-clockwise

Current Field - Input Option 0

There is an input option for determining the static deflections of a cable system immersed in a currentless environment. This is current field input option 0. This option is automatically processed when any of the subsequently described current field input options are exercised. It can be exercised independently.

Current Field - Input Option 1

The current field option 1 is taken to be unidirectional and horizontal, though depth dependent in magnitude. The direction of the current is specified from the magnetic north axis by using the ANG card. [Within the code, the current is referenced to the array coordinate system for calculation purposes. Thus, if the direction of the flow with respect to the X-axis is denoted by θ, the current field is expressed by:

$$V_1 = V(Z)(\underline{e}_1 \cos \theta + \underline{e}_2 \sin \theta)$$

Here, $\underline{e}_1$, $\underline{e}_2$ are unit base vectors with respect to the X- and Y- axes, respectively.] V(Z) specifies the magnitude of the current as a function of depth, Z. This functional relationship must be tabulated as in Table 2.

Table 2. Current Tabulation - Option 1

Column 1	Column 2
Z coordinate (ft)	V(Z) knots

Up to 25 rows are permitted in Table 2. At least one of the Z-coordinates in Table 2 must be less than or equal to the Z-coordinate of the lowest anchor. A sorting scheme is invoked within the program that arranges Table 2 data according to ascending values of Z. Such sorting is necessary within the program for the determination of the current of an arbitrary depth. This is accomplished via a linear interpolation of the currents using the data at the two depths encompassing the depth of interest.

Figure 5 illustrates the magnetic-referenced coordinate system and the linear interpolation of the velocity between given data points.

For current field input option 1, the directionality of the current is a constant for the entire velocity field. Also, for any point (X, Y) on the plane (Z = constant), the value of velocity is invariant.

Current Field - Input Option 2

Current field input option 2 is a slight generalization of the current field input option 1. The generalization involves allowing the current direction θ to vary with depth. The input specification for this option requires depth Z, current magnitude and current direction from the magnetic north axis. The positive direction of rotation is clockwise in the magnetically-aligned reference coordinate system and a zero degree current flows due north. The current specification for option 2 requires a tabulation as in Table 3.

Table 3. Current Tabulation - Option 2

Column 1	Column 2	Column 3
Z-coordinate	V(Z) magnitude, knots	θ(Z) direction, degrees from magnetic N-axis, positive in clockwise sense

Up to 25 rows are permitted in Table 3. The velocity sorting scheme is invoked by the program. One entry for this data must correspond to a depth less than or equal to the Z-coordinate of the lowest anchor. The above current magnitude and direction data are used to generate velocity components along the (X, Y) axes. To obtain the velocity at an arbitrary depth, linear interpolation is performed using the (X, Y) velocity components above and below the depth of interest; the angular direction of the current is also found by interpolation.

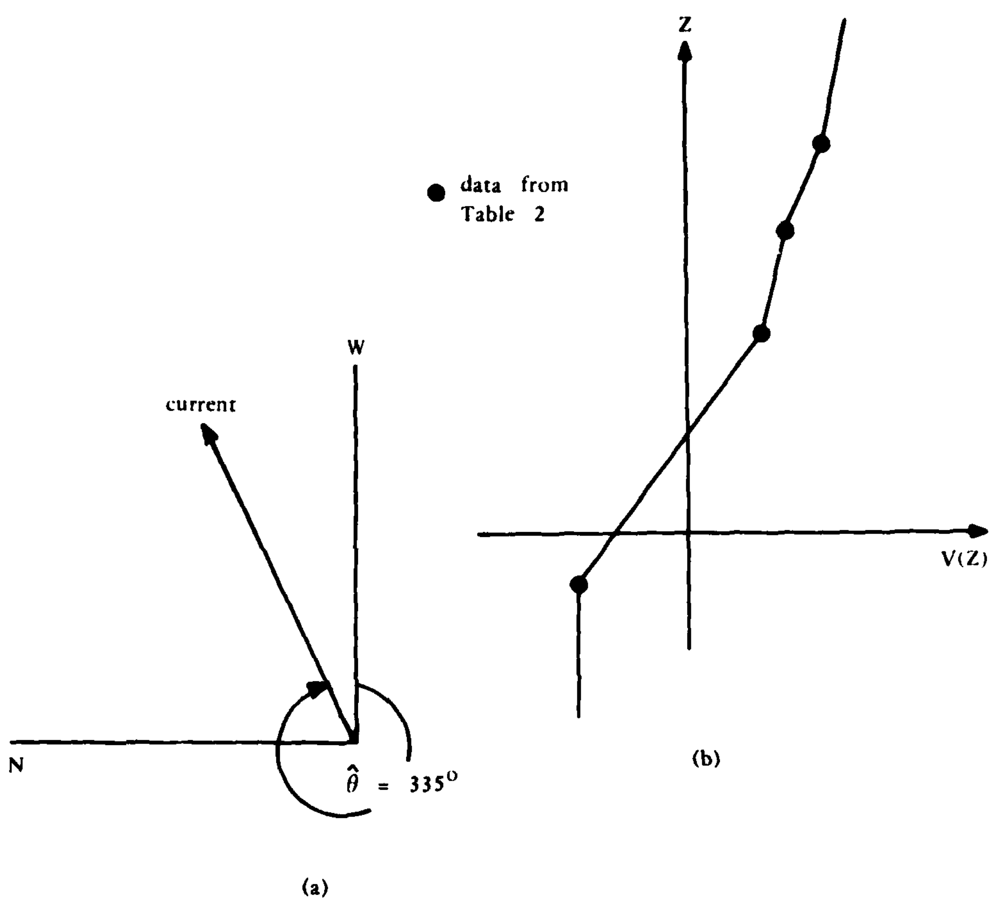


Figure 5. Current field option 1 used in DECEL1 (a) Current angle, θ, (b) Current profile, V(Z).

For current option 2, the value of velocity at any (X, Y) point on the plane Z = constant is invariant.

An ANG card can be used to rotate the entire current profile in the same manner that a unidirectional current profile is rotated.

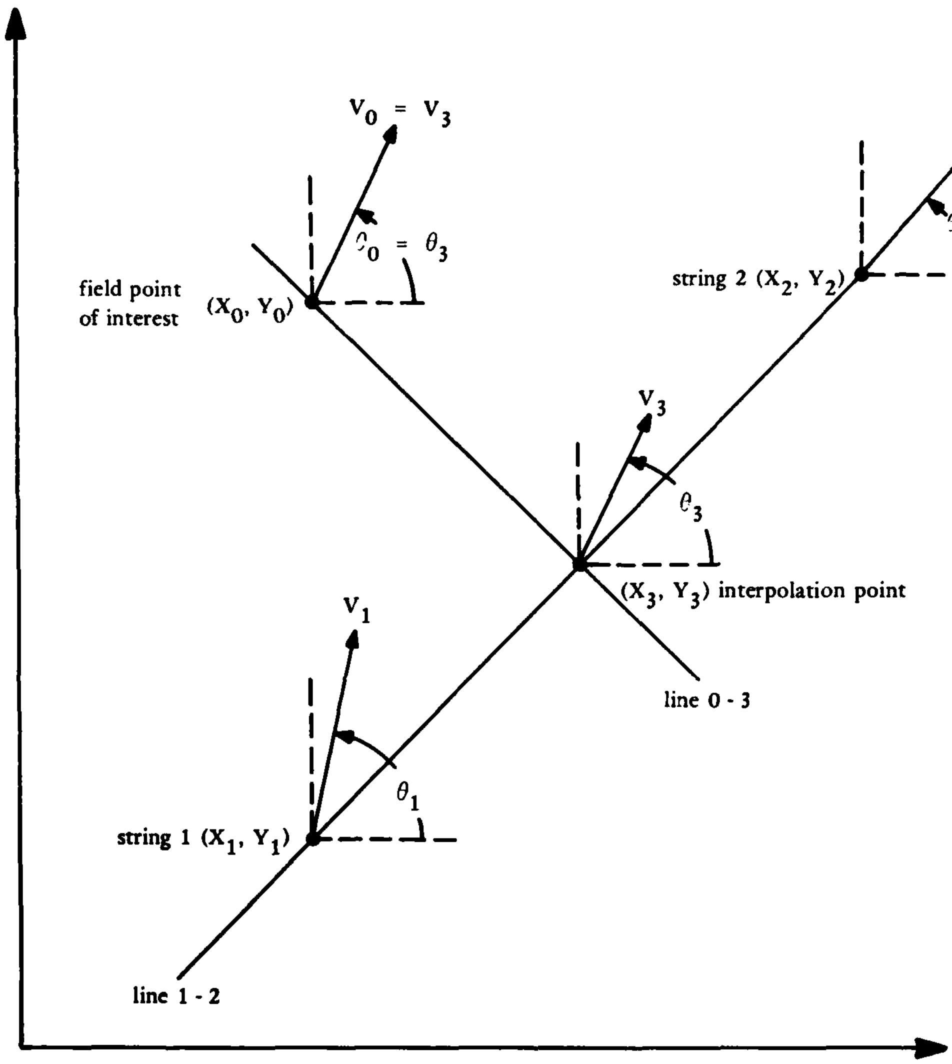
Current Field - Input Option 3

The current field input option 3 employs a linear interpolation/extrapolation scheme on current (magnitude and direction) data to give velocity variation in horizontal planes. When this option is invoked the program expects current data from 2, 3 or 4 current meter strings. Up to 25 measurements of current data can be contained on each string. For each string the first data entry must be at a depth equal to or less than the lowest anchor. The depth dependent data on the various strings do not have to correspond one to the other. That is, if on one string current data are obtained at Z_1, Z_2, Z_3, ... Z_n, then on the other strings data can be collected at completely different depths. This current field input option has been designed to treat mildly varying current fields. It does not provide acceptable results for eddy currents or reverse shear flows. The interpolation/extrapolation scheme to obtain the velocity at an arbitrary point in the field works as follows:

Case of 2 Strings. The field point (X_o, Y_o, Z_o) is determined where the velocity is to be found. On the plane $Z=Z_o$ there are three points of interest. They are (X_o, Y_o, Z_o), (X_1, Y_1, Z_o) and (X_2, Y_2, Z_o) where the last two points denote the location on the plane $Z=Z_o$ at the meter strings. At each of these locations current magnitude and direction data are determined by a straight line interpolation of the data values given directly above and below the Z_o elevation. Figure 6 illustrates the situation after this linear interpolation. There, (V_1, θ_1) and (V_2, θ_2) are obtained from the vertical interpolation just mentioned.

A line normal to the line connecting (X_1, Y_1) and (X_2, Y_2) through the field point (X_o, Y_o) is constructed to locate the interpolation point (X_3, Y_3). The point (X_3, Y_3) lies on the line joining (X_1, Y_1) and (X_2, Y_2). Linear interpolations are now performed to find V_3 and θ_3 from the corresponding values at (X_1, Y_1) and (X_2, Y_2). The current (V_3, θ_3) are assumed to prevail at all points along the normal line. Hence, (V_3, θ_3) provide the description of the current at the field point (X_o, Y_o).

Case of 3 Strings. Suppose the field point is (X_o, Y_o, Z_o). The current magnitude and direction are determined by linear vertical interpolation at the three string locations (X_1, Y_1, Z_o), (X_2, Y_2, Z_o) and (X_3, Y_3, Z_o). The corresponding velocity data obtained at these locations are (V_1, θ_1), (V_2, θ_2) and (V_3, θ_3). At the string location on the horizontal plane ($Z=Z_o$) V_1, V_2 and V_3 are amplitudes through which a velocity plane can be passed. (A unique plane can be passed through any three non-colinear points.) The velocity V_o at the field point (X_o, Y_o, Z_o) then can be obtained by determining the amplitude on the velocity plane corresponding to the position (X_o, Y_o, Z_o). The procedure is exactly the same for the determination of the current direction θ_o. For this quantity a direction plane has to be established using the direction amplitudes θ_1, θ_2 and θ_3.



Line 0 - 3 is orthogonal to line 1 - 2. The velocities (V_1, θ_1) and (V_2, θ_2) are obtained by linearly interpolating string 1 and string 2 data, respectively. The velocity of any point along line 1 - 2 can be obtained by linear interpolation/extrapolation of the velocities (V_1, θ_1), (V_2, θ_2). The assumption is made that the velocity (V_3, θ_3) of an arbitrary point (X_3, Y_3) on line 1 - 2 is propagated along the orthogonal trajectory to that line at that point.

Figure 6. Interpolation/extrapolation in the case of 2-string data.

Case of 4 Strings. The field point is (X_o, Y_o, Z_o). The string points are (X_1, Y_1, Z_o), (X_2, Y_2, Z_o), (X_3, Y_3, Z_o) and (X_4, Y_4, Z_o). Through any three of the string points the procedure used in the preceding case can be repeated exactly. There are four independent ways that three points can be selected from four points, namely: (1, 2, 3); (1, 3, 4); (1, 2, 4); (2, 3, 4). The current is determined at the field point by averaging the results obtained by applying the case of three strings four times to the four combinations of points just indicated.

TANGENTIAL DRAG

The tangential drag computation on the cable is straightforward and is based on the expression

$$\Delta F_{TD}\begin{pmatrix} X \\ Y \\ Z \end{pmatrix} = \frac{1}{2}\,\rho\,[\pi D(1+\varepsilon)]\,C_{DT}\,V_{TM}\,V_T\begin{pmatrix} X \\ Y \\ Z \end{pmatrix}$$

where $\Delta F_{TD}\begin{pmatrix} X \\ Y \\ Z \end{pmatrix}$ = tangential drag force component per unit length in the direction X, Y or Z

$V_T\begin{pmatrix} X \\ Y \\ Z \end{pmatrix}$ = tangential velocity component along X, Y or Z axis

V_{TM} = $\sqrt{V_T^2(X) + V_T^2(Y) + V_T^2(Z)}$, magnitude of tangential velocity

C_{DT} = tangential drag coefficient

ρ = density of fluid

D = cable diameter

ε = strain developed by cable tension

The above calculation forms a part of the hydrodynamic cable drag force. The hydrodynamic force is comprised of a normal drag and a tangential drag.

CABLE DEVICES

In FUNCTION EFORCE (I, M, N) the tangential drag contribution to in-line devices is included in the drag calculation. It is required therefore to supply a tangential drag coefficient for each in-line device as input.

For in-line cable devices the weight of the cable and the hydrodynamic drag over a portion of the cable covered by an in-line device is deleted. Cable devices are referred to as in-line or free devices (two types). All cable devices are numbered automatically within the program. The numbering is accomplished sequentially with respect to cable number

and location of the device away from its s=o end. That is, if on cable 1 there are three cable devices located at $s=s_1$, $s=s_2$, and $s=s_3$ with a $s_3>s_2>s_1$, then cable device indices 1, 2, 3 refer to devices located on cable 1 at $s=s_1,s_2,s_3$, respectively.

REFERENCE CONFIGURATION

An option exists to specify a particular parametric study case as a new no current reference configuration. Displacements with respect to the new no current reference configuration as well as the displacement from the original no current reference configuration are part of the output.

ITERATION CONTROL AND EXECUTION ERROR MESSAGES

To protect the user from excessively high execution costs coupled with the risk of not receiving any output, iteration limits have been added to DECEL1. Two separate iteration processes are involved: one attempts to satisfy the displacement constraints, where the cuts are made, imposed by the COMP card; where the other determines the structure's shape. Both iteration processes have been observed on rare occasions to converge very slowly, if at all.

The first iteration process deals with the imaginary reactions. The associated displacement errors have been observed to be large and to change slowly in some slowly convergent problems. An arbitrary definition of slow convergence coupled with a maximum iteration limit is used to terminate execution of a particular parametric case. Slow convergence has been defined to occur when, after half of the iteration limit is achieved, the displacement error is large (100 times the COMP value) and the error is changing by less than the COMP value per iteration. Iteration is terminated due to slow convergence with the message: SLOW CONVERGENCE AFTER XXX ITERATIONS. The previous and present displacement error values are printed to aid in determining how closely the solution has converged. If only one of the slow convergence criteria is satisfied iteration will continue until convergence occurs or the iteration limit is reached. Iteration is terminated due to reaching the iteration limit with the message: NO CONVERGENCE IN XXX ITERATIONS and the present and previous displacement error values are printed.

The second iteration process to determine the structure's shape occurs after the imaginary reaction iteration has been successful. This process has been observed on some occasions to oscillate about the correct solution. The normal iteration process is allowed to continue until half of the nodal position iteration limit is reached. At this point, the solution is arbitrarily assumed to be oscillating and a half-step iteration scheme is imposed (the iteration process is unchanged except that each node is allowed to move only half as far as calculated). This half-step technique continues until the iteration limit is reached or convergence occurs. Execution of the parametric case is terminated with the message: PROGRAM DID NOT CONVERGE AFTER XXX ITERATIONS, PARAMETRIC CASE TERMINATED. The displacement error is printed and the full output for the case is printed preceded by the message: APPROXIMATE RESULTS PRINTED. The user must judge if an adequate displacement error has been achieved for the results to be meaningful.

What To Do If . . .

When execution has been terminated by reaching the imaginary reaction iteration limit, several options are still available. The iteration limit (field 4 of the COMP card) can be increased; however, this probably will have to be done in conjunction with an increase in the COMP value. The COMP value should still be kept in a range that will be judged to produce usable results. The error values printed upon execution termination will give an idea of how much the COMP value will have to be increased.

In some cases, the desired current is too strong to apply in one step; strong currents have caused the imaginary reaction iteration limit to be reached. To handle this and other sensitive cases, an option has been added to apply the current in increments (field 11 of the NDAT card). Using this option, the program iterates to a solution for the first current increment as if this were the total current to be applied. Then the current is incremented and the process is repeated. An option exists to print the solution for each increment of the current (see field 11 of the NDAT card). This technique has been highly effective in obtaining solutions in high currents up to 10 knots.

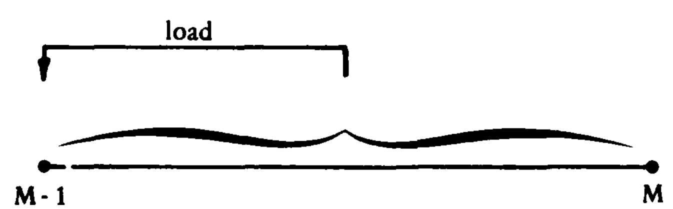
DECEL1 USER EXPERIENCE

In the course of using DECEL1 a wide variety of structures in various current profiles have been analyzed. Some results have been compared with experimental data with close agreement (Ref 7). Other cases have been cross-checked against other computer models again with good agreement. The program is easy to use to the point that a user with a general engineering background can use the manual to formulate the required input and expect to receive back usable results once obvious input errors are corrected. The ease of use is an exceptional attribute of the program.

In the course of making modifications to the program a great deal of insight has been gained regarding the mathematical modeling. Many of the details are of no importance to the user. However there are several characteristics that the user should be aware of; these deal with the internal distribution of loads, non-convergent problems, and the convergence parameter.

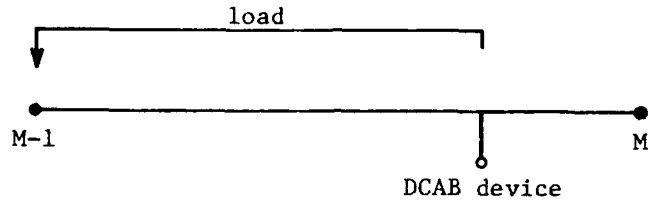
Load Distribution

Loads (weight and drag) are generated from three sources: cables, cable devices, and junction devices. Cable forces due to drag and weight are calculated for the cable length between two nodes [length = (total cable length)/(no. of elements in the cable)]. (See CAB card.) The forces are assigned to the M-1 node as shown below:



Clearly, the smaller the distance between the nodes, the more accurate the mathematical representation.

Loads due to devices on the cable (DCAB card) are modeled in a similar way except that the device is physically located at a specific point along the cable between the two nodes. The DCAB loads are modeled as shown below:



This is a good representation when the device is actually near node (M-1). However, when the device is near node M and the distance between the nodes is large, this may be a poor representation. This is not to say the computer results will be grossly in error; this depends upon the size and number of DCAB devices. If the devices are few and/or small such that the system is cable-load dominated, the results should be acceptable.

Probably the most serious error will arise when there are few elements and the DCAB devices produce large static or drag loads. In this case large loads may be assigned to locations quite distant from their actual point of application.

Loads due to DJNC devices are most accurately modeled. The loads are assigned exactly where the device is located.

It may appear that a better modeling of cable and DCAB loads could be achieved by proportioning the loads between the appropriate adjacent nodes. However, this single change is not consistent with other internal force accounting schemes. To implement force proportioning, a major re-write of the program would be required; this has not been done.

As the program stands, the majority of problems can be analyzed with wholly satisfactory results even ignoring the way loads are distributed. Where the load distribution scheme is judged by the user to pose a problem in obtaining a satisfactory model, the following suggestions are presented.

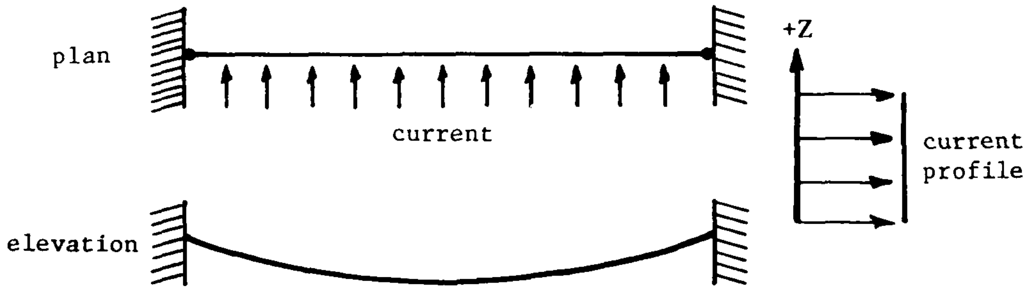
1. Model all cables with as many elements as possible (50). This will make the distance between nodes least so that DCAB loads will be assigned as close to the actual device location as possible.

2. Model large bodies as DJNC devices - loads will be assigned exactly where the device is located.

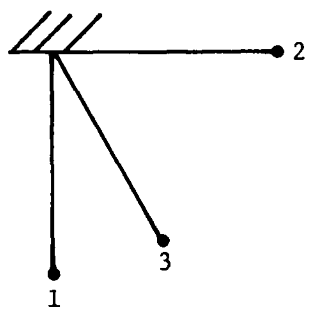
3. Model long cables as a series of shorter series-connected cables. This will aid in making elements short.

Non-Convergent Problems

DECEL1 treats statically determinate and statically indeterminate problems differently. The indeterminate problems are solved using the imaginary reaction technique (Ref 1). This is a powerful method and usually converges rapidly to a solution. (Reference 1 shows that the method is unconditionally convergent.) However, at least one case has been encountered where the method is at best very slowly convergent. The case involves a nearly neutrally buoyant cable hung in a catenary between two fixed points with a strong current acting perpendicular to the plane of the catenary:

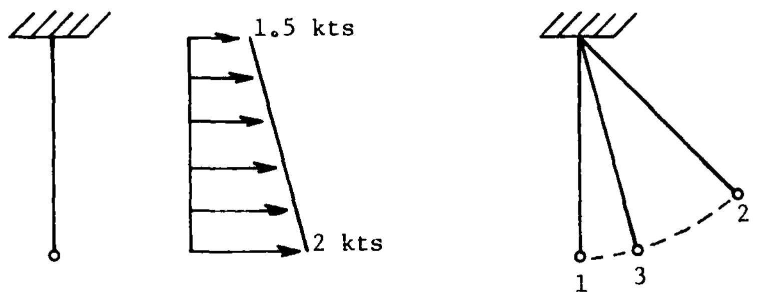


The positions attained by the cable during the iteration procedure are sketched below.



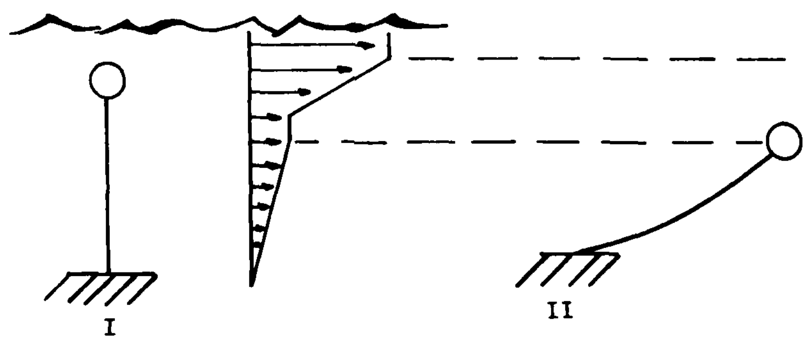
The cable is initially driven from the no-current position (1) to a nearly horizontal position (2). Here there is low- or no-normal drag to support the cable so in the next iteration it falls to position (3) (which may be coincident with position (1)). Internally, the iterations appear to oscillate between positions (2) and (3), and the solution fails to converge. Convergence can be achieved by reducing the current or by increasing the weight of the cable.

Statically determinate cases bypass the imaginary reaction routine, thus convergence is not as certain. There are combinations of current and geometry that interact in such a way as to appear to be unstable. An example is a lightweight anchor suspended from the surface in a current that increases with depth.



From the no-current position (1), the first iteration is to position (2) where the normal drag force is reduced both because of the orientation change (toward horizontal) and the reduced current in the new position. The reduced loading causes the system to attain position (3). The solution then oscillates between positions (2) and (3). Whether another case using this configuration will converge or not depends on both the magnitude of the current and the system weight. The particular case in question probably would converge in a more uniform current field or if the system weight were to be increased.

Another non-convergent case involved a sharp change in the velocity profile.



The subsurface buoy was initially in a high current zone (sketch I); in the first iteration it moved to a lower current region (sketch II). Here the high current was no longer acting on the system so on the next iteration the buoy was moved back into the high current regime. This case failed to converge primarily because the current shear was very near the initial depth of the buoy. Thus the buoy moved in and out of the high current on subsequent iterations. If the current shear had been much below the buoy and always acted only on the cable the solution most likely would have converged.

The above cases are presented simply to illustrate non-convergent problems. They by no means represent all non-convergent cases; however, they serve to illustrate what kinds of situations can be difficult to solve. If a user encounters a case that does not converge, the discussion of the examples here will help guide his reasoning in determining why non-convergence occurs.

In an attempt to improve the iteration technique, a half-step iteration technique has been introduced. The process is implemented only after 100 standard iterations have occurred. (The 100 iteration number has been relatively arbitrarily judged to be an indicator of oscillation during iteration.) After the first 100 iterations have occurred the next 100 iteration steps are calculated in the same way but the allowed displacement is reduced by one-half. This approach has not yet (as of this writing) been user tested; however, initial tests indicate that formerly oscillating cases will converge to a solution. As part of the half-step technique, an informative printout has been added that states the number of iterations required to achieve convergence. After 200 total iterations have occurred, iteration will be stopped, a message printed and the next parametric case will be analyzed. (The 200 iteration limit is arbitrarily taken as an indicator that the solution is not converging.)

Convergence Parameters

The variable on the COMP card is used as the convergence test parameter. The discussion of the COMP card defines a lower limit for the parameter that can be quite small. Iteration continues until two consecutive calculated positions for each node on the structure differ by less than the convergence parameter. Very small values of the convergence parameter can cause certain "sensitive" cases (such as some of those discussed above) to appear to oscillate. Adequate solutions and more rapid convergence can be obtained by picking a convergence parameter value that is consistent with the size of the structure being analyzed. The table below lists suggested convergence parameter values that are consistent with the structure size as determined by cable length.

Cable Length (ft)	Convergence Parameter (ft)
<10	<0.01
<100	0.01-0.1
<1000	0.1-1.0
<10,000	1.0-10.0
>10,000	5.0-20.0

These are only suggested values that may be used as initial values in order to insure that successful convergence does occur. For particular problems the user must judge for himself the adequacy of the convergence tolerance chosen. However, the user must realize that an unnecessarily small convergence parameter can cause a case to fail to converge mathematically even though a physically adequate solution has been reached in the iteration process.

INPUT CARDS

Input cards to DECEL1 contain a 4-digit integer (-999 to 9999) card number in columns 1-4, a 4-character card type identifier in columns 5-8, and descriptive properties of the array in the remaining fields with the exception of the following input cards.

1 - Main Descriptive Title Card
2 - Parametric Descriptive Title Card
3 - Continuation Card for CAB
4 - Velocity Field for Current Option 3

The card number has two uses. First, it is used as a convenience for the user to define the order of the cards in the deck, should the deck be dropped. Secondly, it is used as a cross-check in changing parameters in the Parametric Study Source Deck: when a parameter on a card is to be changed, both the card number and type must match the card in the Cable Array Source Deck or an error will occur. In the Cable Array Source Deck, duplicate card numbers are detected as errors; however, any number of input cards may have the card number omitted with no errors.

** CABLE ARRAY SOURCE DECK CARDS **

LUN CARD (optional card; if used it must be the first card in the deck)

Field	Columns	Format	Contents	Comments
1	1-4	I4	Card number (optional)	-999 to 9999
2	5-8	A4	^LUN	Right adjust
3	9-16	I8	Unit number of card reader	
4	17-24	I8	Unit number of line printer	
5	25-32	I8	Unit number of temporary storage tape	
6	33-40	I8	Input option (0 or 1)	See notes
7	41-48	I8	Blank if input option = 0. Unit number of source tape if input option = 1.	
8	49-56	I8	Output option (0, 1 or 2)	See notes
9	57-64	I8	Blank if output option = 0. Unit number of output tape or card punch if output option = 1 or 2.	
10	65-72		Not used	See notes
11	73-77		Not used	
12	78-80		Not used	

NOTES: 1. The carot symbol (^) is used to indicate one blank column in the position shown.

2. The LUN card is used to transmit the logical unit numbers of of the I/O devices and the I/O options. The LUN card is optional. If it is omitted then input option 0 and output option 0 are the default options.

Two input options are available:

0 - The physical characteristics of the array are to be read from the cable array source deck (see CABLE ARRAY SOURCE DECK)

1 - The physical characteristics of the array are to be read from the cable array source tape (see CABLE ARRAY SOURCE TAPE)

Three output options are available:

0 - A structural output to the line printer (see STRUCTURAL OUTPUT)

1 - A device location output to tape or cards (see DEVICE LOCATION OUTPUT)

3 - both of the above

MAIN DESCRIPTIVE TITLE CARD

Field	Columns	Format	Contents	Comments
1-10	1-80	8A10	Main descriptive title	See notes

NOTE: A single "Main Descriptive Title Card" must always follow the LUN card. If no title is desired a blank card must be inserted. This card does not adhere to the convention requiring a card number and card type, so that the entire card can be utilized for a title. If the LUN card is omitted then this must be the first input card.

NJNC CARD

Field	Columns	Format	Contents	Comments
1	1-4	I4	Card number (optional)	-999 to 9999
2	5-8	A4	NJNC	
3	9-16	I8	Number of junctions in original (unreduced) array	2-44
4	17-24		Not used	
5	25-32		Not used	
6	33-40		Not used	
7	41-48		Not used	
8	49-56		Not used	
9	57-64		Not used	
10	65-72		Not used	
11	73-77		Not used	
12	78-80		Not used	

NOTE: The NJNC card is used to transmit the number of junctions in the original (unreduced array).

ANC CARD

Field	Columns	Format	Contents	Comments
1	1-4	I4	Card number (optional)	-999 to 9999
2	5-8	A4	‸ANC	Right adjust
3	9-16	I8	Junction number of anchor	1-44
4	17-24	F8.0	X coordinate of anchor	ft
5	25-32	F8.0	Y coordinate of anchor	ft
6	33-40	F8.0	Z coordinate of anchor	ft
7	41-48		Not used	
8	49-56		Not used	
9	57-64		Not used	
10	65-72		Not used	
11	73-77		Not used	
12	78-80		Not used	

NOTE: The ANC cards are used to transmit the data in Table 1. There must be one ANC card for each anchor in the array.

IR CARD

Field	Columns	Format	Contents	Comments
1	1-4	I4	Card number (optional)	-999 to 9999
2	5-8	A4	^^IR	Right adjust
3	9-16	I8	Junction number assigned to a cut in the reduced array	1-44
4	17-24	I8	Junction number at which cut is made in the original array	1-44
5	25-32		Not used	
6	33-40		Not used	
7	41-48		Not used	
8	49-56		Not used	
9	57-64		Not used	
10	65-72		Not used	
11	73-77		Not used	
12	78-80		Not used	

NOTE: The IR cards are used to transmit the information contained in the table below the left-hand schematic of each of Figures 3a-3d. There must be one IR card for each cut made in going from the original to the reduced array.

CAB CARD

Field	Columns	Format	Contents	Comments
1	1-4	I4	Card number (optional)	-999 to 9999
2	5-8	A4	^CAB	Right adjust
3	9-16	I8	Cable number	1-22
4	17-24	I8	s=0 junction number	1-44
5	25-32	I8	s=L junction number (after required cuts are made)	1-44
6	33-40	F8.0	Cable weight per length in surrounding fluid; + if positively buoyant, - if negatively buoyant	lb/ft
7	41-48	F8.0	Normal drag coefficent of cable	
8	49-56	F8.0	Cable diameter	in.
9	57-64	F8.0	Total cable length (unstressed)	ft
10	65-72	F8.0	Cable rigidity, C (see notes) if k=1, C=EA	lb
11	73-77	F5.0	Exponent in constitutive relation, k (see notes)	≥ 0
12	78-80	I3	Number of straight elements by which cable is to be represented	$>0, \leq 50$

NOTE: The CAB cards are used to transmit the information contained in the table below the right-hand schematic in Figures 3a-3d (fields 3 to 5), the physical characteristics of the cables in the array (fields 6 to 11), and the fineness by which the cables in the array are to be modeled (field 12). There must be one CAB card and one continuation CAB card for each cable in the array. The constitutive relation for a cable can, in general, be written (6) as $\varepsilon=(T/C)^k$ where ε is the

NOTES FOR CAB CARD (continued)

strain and T the tension. C and k are constants which depend on the cable material and construction. Fields 10 and 11 transmit the values of C and k, respectively. An inextensible cable is transmitted to DECEL1 by leaving fields 10 and 11 blank.

CONTINUATION CAB CARD

Field	Columns	Format	Contents	Comments
1	1-8	F8.0	Tangential drag coefficient of cable	See notes
2	9-80	9F8.0	Not used	

NOTE: Each CAB card must be followed by an additional card. If no tangential drag is desired a blank card must be inserted. This card does not adhere to the convention requiring a card number and card type since it is in fact a continuation of the tangential drag coefficient. Default value is zero.

DCAB CARD

Field	Columns	Format	Contents	Comments
1	1-4	I4	Card number (optional)	-999 to 9999
2	5-8	A4	DCAB	
3	9-16	I8	Number of cable to which device is attached	1-22
4	17-24	I8	Device type (1,2)	See notes
5	25-32	I8	Print flag for cable devices. If flag = 0, print device characteristics and location. If flag ≠ 0, don't print.	
6	33-40	F8.0	Device weight in surrounding fluid; + if positively buoyant, - if negatively buoyant	lb (See note 3)
7	41-48	F8.0	Normal drag coefficient	
8	49-56	F8.0	Diameter on which drag coefficient is based (Type 1) Frontal area on which drag coefficient is based (Type 2).	in. ft^2
9	57-64	F8.0	Device length (Type 1)	ft
10	65-72	F8.0	Unstressed distance of device from s=0 junction of the cable	ft
11	73-77	F5.0	Tangential drag coefficient	
12	78-80		Not used	

NOTE: 1. The DCAB cards are used to transmit the physical characteristics of the discrete devices (buoyancy elements, current meters, etc.) attached to the cables in the array. There must be one DCAB card for each such device

NOTES FOR DCAB CARD (continued)

in the array. Two types of devices are permitted: (a) in-line (Type 1) any elongated device (cylinder, ellipse, etc.) attached so that its longitudinal axis is aligned with the cable axis; and (b) free devices (Type 2).

2. Dummy DCAB devices with no weight and zero drag can be used as conveniences to print the location of the device in the cable array's deformed state. With no DCAB devices, no information about the cable shape between junctions is printed.

3. Include cable weight in water if device covers segment of cable.

Each device is automatically assigned a unique number based on its location on the structure. Low numbered devices are located on low numbered cables. On each cable the lowest number device is nearest the s=o end of the cable.

DJNC CARD

Field	Columns	Format	Contents	Comments
1	1-4	I4	Card number (optional)	-999 to 9999
2	5-8	A4	DJNC	
3	9-16	I8	Number of junction to which device is attached	1-44
4	17-24	I8	Not used	
5	25-32	I8	Not used	
6	33-40	F8.0	Device weight in surrounding fluid; + if positively buoyant, - if negatively buoyant	lb
7	41-48	F8.0	Device drag coefficient	
8	49-56	F8.0	Frontal area on which drag coefficient is based	ft^2
9	57-64		Not used	
10	65-72		Not used	
11	73-77		Not used	
12	78-80		Not used	

NOTE: The DJNC cards are used to transmit the physical characteristics of the discrete devices attached to the junctions in the array. There must be one DJNC card for each such device in the array.

Since an in-line device cannot physically exist at a junction (cable termination), only free devices are permitted at a junction.

DJNC devices are indexed automatically for counting purposes only; they are counted in the total number of indexed devices.

DEN CARD

Field	Columns	Format	Contents	Comments
1	1-4	I4	Card number (optional)	-999 to 9999
2	5-8	A4	‸DEN	Right adjust
3	9-16	F8.0	Density of fluid in which array is suspended	lb s^2 ft^{-4} (1.99 for seawater)
4	17-24		Not used	
5	25-32		Not used	
6	33-40		Not used	
7	41-48		Not used	
8	49-56		Not used	
9	57-64		Not used	
10	65-72		Not used	
11	73-77		Not used	
12	78-80		Not used	

NOTE: The DEN card is used to transmit the density of the fluid in which the array is suspended.

EOD CARD

Field	Columns	Format	Contents	Comments
1	1-4	I4	Card number (optional)	-999 to 9999
2	5-8	A4	‸EOD	Right adjust
3	9-16		Not used	
4	17-24		Not used	
5	25-32		Not used	
6	33-40		Not used	
7	41-48		Not used	
8	49-56		Not used	
9	57-64		Not used	
10	65-72		Not used	
11	73-77		Not used	
12	78-80		Not used	

NOTE: The EOD card is used to specify the end of data transmission.

** PARAMETRIC STUDY SOURCE DECK CARDS **

NDAT CARD

Field	Columns	Format	Contents	Comments
1	1-4	I4	Card number (optional)	-999 to 9999
2	5-8	A4	NDAT	
3	9-16	I8	Current field option	See note 1
4	17-24	I8	Number of stations at which current data is taken for current field option 3. Otherwise not used.	See note 2
5	25-32	I8	Option for defining a particular parametric study as the new no current reference configuration. Option = 0, no new ref. config. Option ≠ 0, new ref. config.	
6	33-40	F8.0	PHI	degrees See note 3
7	41-48	F8.0	Device location punch output option; option ≠ 0, punch device locations on cards	See note 4
8	49-56	F8.0	Weight of device whose location is to be punched	lb
9	57-64		Not used	
10	65-72	F8.0	Velocity units input option	See note 5
11	73-77	F5.0	Number of steps used to apply full current	See notes 6 and 7 (default value = 1.0)
12	78-80		Not used	

SEE NEXT PAGE FOR NOTES

NOTE:

1. The NDAT card is used to specify that new, modified, or additional data follow and to transmit the current field option. Three current field options are available.

   0 - No current.

   1 - Current field is unidirectional and horizontal. (There is no vertical component.) The current magnitude can vary with depth. At any point in the plane Z-constant, the velocity is invariant. The no-current configuration is also calculated as part of this option.

   2 - Same as current field option 1 except that the current can have a directionality that depends on depth. That is, this option relaxes the unidirectional constraint on the velocity field. At any point in the plane Z-constant, the velocity is invariant. An example of a possible current candidate requiring this option would be a helical current where the axis of the helix is aligned with gravity. The no-current configuration is also calculated as part of this option.

   3 - Interpolation/extrapolation scheme for field current (magnitude and direction) data. The current is assumed to have no vertical component. Two, three, or four stations can be selected in the horizontal plane and at each of these stations, current (direction and magnitude) data can be obtained at up to 25 elevations. This option affords current variation in horizontal planes. The no-current configuration is also calculated as part of this option.

2. For current option 3, the value in field 4 on the NDAT card must appear on all successive NDAT cards even if the velocity field is not to be varied in any of the parametric studies.

3. The angle ϕ specifies the rotation of the X-axis from the N-axis. ϕ is measured positive in the clockwise sense and the N-axis is $\phi=0$. That is, when $\phi=0$ then the (N,W) coordinate system is coincident with the (X,Y) coordinate system (see Figure 4). The ϕ value should appear on each NDAT card.

4. It is sometimes desirable to have the locations of particular devices punched on cards for input to other programs. For example, both hydrophones and buoys may be distributed as DCAB devices along the structure, but only the location of the hydrophones is important. By specifying field 7 $\neq$ 0 and field 8 = hydrophone weight, DECEL1 will punch for each hydrophone: (a) device index, (b) cable number, (c) distance from the s = 0 end of the cable, and (d) x,y,z coordinates of the device. Preceding this punched output is a card totalling the number of cards in the punched output.

NOTES FOR NDAT CARD (continued)

5. Velocity units input option:

   0 - input magnitude of velocity in knots (default)
   1 - input magnitude of velocity in cm/sec
   2 - input magnitude of velocity in ft/sec

6. This is a coded value: the integer portion represents the number of steps used to apply the full current; the fractional part controls printed output: a non-zero fractional part (i.e., 10.1) causes the shape calculated for each increment of the current to be printed. For example: the value 10.1 will cause the current to be applied in ten equal increments and the structure shape will be printed for each increment. A 10.0 value will apply the current in ten increments but print only the shape with the full current value applied. If plotting is requested, only the shape with the full current applied is plotted.

7. This input option is intended to aid in obtaining solutions where high currents cause SLOW/NO CONVERGENCE messages to be printed.

PARAMETRIC DESCRIPTIVE TITLE CARD

Field	Columns	Format	Contents	Comments
1-10	1-80	8A10	Parametric descriptive title	See notes

NOTE: Descriptive Title Card must always follow an NDAT card. If no title is desired, then a blank card must be inserted. This card does not adhere to the convention requiring a card number and card type, so that the entire card can be utilized for a title.

COMP CARD

Field	Columns	Format	Contents	Comments
1	1-4	I4	Card number (optional)	-999 to 9999
2	5-8	A4	COMP	
3	9-16	F8.0	Accuracy required in array equilibrium calculations (COMP value)	ft (0.01 typ)
4	17-24	F8.0	Nodal position iteration limit	See note 2 (200 default value)
5	25-32	F8.0	Imaginary reaction iteration limit	See note 2 (1000 default value)
6	33-40		Not used	
7	41-48		Not used	
8	49-56		Not used	
9	57-64		Not used	
10	65-72		Not used	
11	73-77		Not used	
12	78-80		Not used	

NOTES:

1. The COMP card is used to transmit the accuracy requirement imposed on the array equilibrium calculations. This accuracy requirement, specified in field 3, insures that the calculated coordinates of every point in the array are within ± field 3 of their exact values.

   The accuracy obtainable is limited by the significant figure capacity of the computer being used and by the largest linear dimension in the array. Let the number of significant figures carried in single precision be n, and let the characteristic of the common logarithm of the largest linear dimension be m. Then, the value of field 3 is usually bounded by field 3 $\geq 10^{m-n+3}$. (For example, suppose n = 8 and the largest dimension is 25,000 ft. Then, field 3 $\geq$ 0.1 ft.) Occasionally, a larger minimum value must be used. A

NOTES FOR COMP CARD (continued)

COMP card must appear after the first NDAT card. See PARAMETRIC STUDY SOURCE DECKS. Accuracy requirements can be changed in subsequent Parametric Study Decks by using new COMP cards.

2. See the descriptions in the text on pages 18 and 19.

VEL CARD

Field	Columns	Format	Contents	Comments
1	1-4	I4	Card number (optional)	-999 to 9999
2	5-8	A4	^VEL	Right adjust
3	9-16	F8.0	Z coordinate at which current velocity is specified	ft
4	17-24	F8.0	Magnitude of current at Z coordinate specified in field 3	knots; cm/sec; ft/sec (consistent with NDAT card)
5	25-32	F8.0	Direction of current at Z coordinate (current option 2 only)	degrees
6	33-40		Not used	
7	41-48		Not used	
8	49-56		Not used	
9	56-64		Not used	
10	65-72		Not used	
11	73-77		Not used	
12	78-80		Not used	

NOTE: The VEL cards are used to transmit the data in Table 2. There must be one VEL card for each value of Z at which the current velocity is specified.

Up to 25 VEL cards are permitted. At least one of the Z coordinates transmitted by the VEL cards must be less than or equal to the minimum Z coordinate transmitted by the ANC cards. For further information see CURRENT FIELD INPUT OPTION 1.

The VEL cards must not appear after an NDAT card specifying a current field option = 0. All VEL cards required to transmit the current profile must appear after the first NDAT card specifying a current field option = 1. See PARAMETRIC STUDY SOURCE DECKS.

A given current profile will be applied in all subsequent parametric cases until a new field is defined.

NOTES FROM VEL CARD (continued)

Current Option 1 - Only the magnitude of the current is input (field 4). The direction is varied by the ANG card.

Current Option 2 - Both magnitude and direction of current are input fields 4 and 5, respectively. The direction of the field also may be modified by the ANG card. Current direction is to be specified from the magnetic north axis. Clockwise rotation is positive.

Current Option 3 - Fields 3, 4 and 5 are ignored. The velocity information is read from the velocity continuation group immediately following the VEL card.

The following is a brief description of the velocity cards under current option 3.

After a VEL card is encountered there will be 2, 3 or 4 sets of velocity data depending on the number of stations at which velocity profiles were measured.

Each set of data for a station will contain one Station Location Card and N Velocity Definition Cards. N is the number of Z-coordinates at which velocity is measured for the particular station. The maximum value of N is 25.

The 2, 3 or 4 sets of data are stacked as indicated in Figure 7.

The Station Location Cards and Velocity Definition Cards are defined on the next two pages.

To further clarify the velocity option 3 data requirements we present another example using 3 stations of current data. The data deck will be arranged as follows:

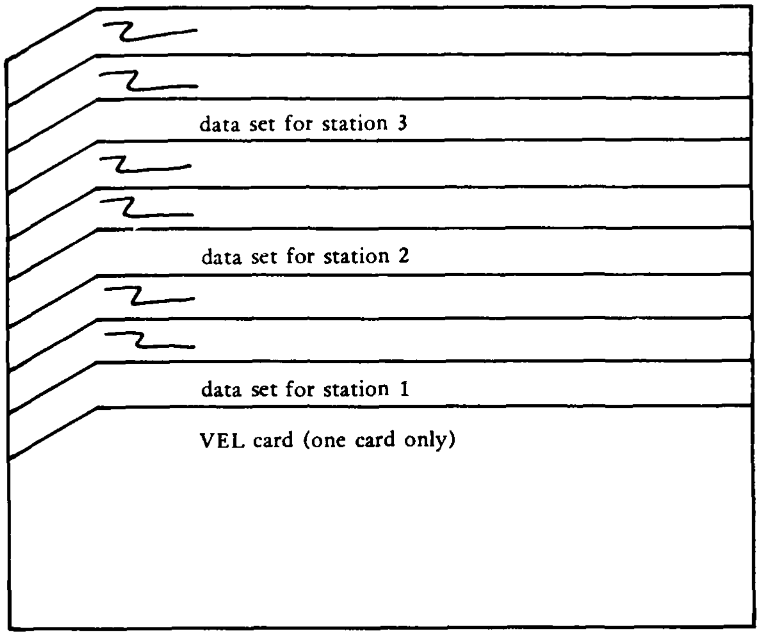


Figure 7. Arrangement of data sets for velocity option 3.

NOTES FROM VEL CARD (OPTION 3 ONLY) (continued)

Field	Columns	Format	Contents	Comments
1	1-5	I5	Station number at which velocity profile measured	
2	6-10	I5	Number of Z-coordinates at which velocity is measured for this station (field 1)	
3	11-20	F10.0	North coordinate of this station*	ft (see notes)
4	21-30	F10.0	West coordinate of this station**	ft (see notes)
5	31-80		Not used	

*Coordinate is positive for north, negative for south.
**Coordinate is positive for west, negative for east.

NOTES FROM VEL CARD (OPTION 3 ONLY) (continued)

Field	Columns	Format	Contents	Comments
1	1-5	I5	Station number	
2	6-10		Not used	
3	11-20	F10.0	Z-coordinate of velocity	ft
4	21-30	F10.0	Magnitude of velocity at Z-coordinate of this station (field 1)*	See notes
5	31-40	F10.0	Direction of current at Z-coordinate of this station (field 1)**	degrees (see notes)
6	41-80		Not used	

NOTE: There must be as many of this card as there are current readings at the station (= field 2 of preceding card).

*The magnitude of velocity may be input in three different units according to the option definition on the NDAT card.

Units Option 0 - knots (default)
Units Option 1 - cm/sec
Units Option 2 - ft/sec (see NDAT card)

**The direction of current is positive in the clockwise sense from the magnetic north axis (degrees).

ANG CARD

Field	Columns	Format	Contents	Comments
1	1-4	I4	Card number (optional)	-999 to 9999
2	5-8	A4	‸ANG	Right adjust
3	9-16	F8.0	Initial current angle	degrees
4	17-24	F8.0	Increment in current angle	deg, > 0
5	25-32	F8.0	Final current angle	deg, ≥ field 3
6	33-40		Not used	
7	41-43		Not used	
8	49-56		Not used	
9	57-64		Not used	
10	65-72		Not used	
11	73-77		Not used	
12	78-80		Not used	

NOTE: The ANG card is used to transmit instructions for changing the angular direction of the current with respect to the N-axis for current options 1 and 2 only. DECEL1 calculates the array response to the specified current profile from the initial to the final current angles in increments transmitted by field 4. An ANG card must not appear after an NDAT card specifying a current field option = 0. One ANG card must appear after the first NDAT card specifying a current field option = 1, 2, or 3. See PARAMETRIC STUDY SOURCE DECKS.

If no parametric range of current direction variation is required, then Fields 3 and 5 should have identical values and field 4 should have a non-zero positive value.

When exercising the angular rotation option, it is important to recognize the difference between current options 1 and 2. For current option 1, the input value in field 3 of the ANG card establishes the directionality of the entire flow field. This is not the case for current option 2 since current directionality is established and specified as input on the VEL card.

NOTES FROM ANG CARD (continued)

For current option 2 the field 3 input value on the ANG card should be set equal to ϕ (the angle between the N- and X-axes) plus the initial angle of interest. The value in field 5 of the ANG card should be set equal to $\phi + \beta$ where β is the total angle through which the current is to be rotated. The value of field 4 is $\Delta\beta$, the increment. When current option 2 is selected and no rotation of the current field is desired, the fields 3 and 5 should be set equal to ϕ and any positive value set in field 4.

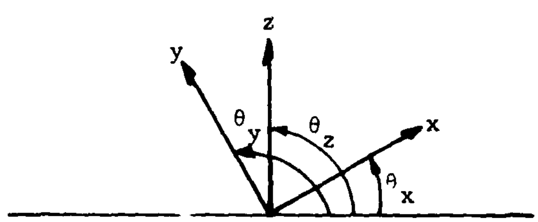
PPLT CARD

Field	Columns	Format	Contents	Comments
1	1-4	I4	Card number (optional)	-999 to 9999
2	5-8	A4	PPLT	
3	9-16	F8.0	Plotting option: 0 - Undeformed only 1 - Deformed only 2 - Both	Undeformed plotted as a dotted line. Deformed plotted as a solid line.
4	17-24	F8.0	Height of plot, y	in. (default 10)
5	25-32	F8.0	View angle, x (see note)	degrees (default 30)
6	33-40	F8.0	View angle, y (see note)	degrees (default 120)
7	41-48	F8.0	View angle, Z (see note)	degrees (default 90)

NOTE: For a plan or elevation view (not a perspective view) one view angle must be 361°. This is a code indicating which axis is perpendicular to the plot. For example, a plan view is specified by:

View Angle, x = 0.001 (0 gives the 30° default value)
View Angle, y = 90°
View Angle, z = 361°

The x, y and z view angles are shown below for the default configuration.



θ_x - View angle for x axis. 30 degrees.
θ_y - View angle for y axis. 120 degrees.
θ_z - View angle for z axis. 90 degrees.

Examples perspective plots are shown in Figures 8-10.

CPLT CARD

<table>
<tr><th>Field</th><th>Columns</th><th>Format</th><th colspan="2">Contents</th><th>Comments</th></tr>
<tr><td>1</td><td>1-4</td><td>I4</td><td colspan="2">Card number (optional)</td><td>-999 to 9999</td></tr>
<tr><td>2</td><td>5-8</td><td>A4</td><td colspan="2">CPLT</td><td></td></tr>
<tr><td>3</td><td>9-16</td><td>F8.0</td><td colspan="2">ZUP-Max. depth plane level</td><td>ft</td></tr>
<tr><td>4</td><td>17-24</td><td>F8.0</td><td colspan="2">ZDN-Min. depth plane level</td><td>ft</td></tr>
<tr><td>5</td><td>25-32</td><td>F8.0</td><td colspan="2">DZ -Delta depth</td><td>ft</td></tr>
<tr><td>6</td><td>33-40</td><td>F8.0</td><td colspan="2">YIN-Height in Y direction of a single plane</td><td>in.</td></tr>
<tr><td>7</td><td>41-48</td><td>F8.0</td><td>XMIN</td><td rowspan="4">Minimum & maximum coord. of area to be covered by plot</td><td rowspan="4">ft (If blank default values selected)</td></tr>
<tr><td>8</td><td>49-56</td><td>F8.0</td><td>XMAX</td></tr>
<tr><td>9</td><td>57-64</td><td>F8.0</td><td>YMIN</td></tr>
<tr><td>10</td><td>65-72</td><td>F8.0</td><td>YMAX</td></tr>
<tr><td>11</td><td>73-77</td><td>F5.0</td><td colspan="2">ANG-View angle Y</td><td>degrees default = 90</td></tr>
<tr><td>12</td><td>78-80</td><td>I3</td><td colspan="2">NY -Number of mesh points in Y direction, including boundary</td><td>default = 6</td></tr>
</table>

NOTE: Current plots may be depicted at one or more depths by varying input parameters ZUP, ZDN, DZ. The vertical height for each plane of the plot is input as YIN, and the corresponding width is calculated by the program. The product of the number of planes and the vertical height of a single plane cannot exceed 10 inches.

The plots may vary in perspective view angle y over the range $0<ANG<180°$, where $ANG = 90°$ is the plan view. For purposes of plotting the current field, each plane is assumed to have z coordinate zero and view angle x equal to zero.

NOTES FROM CPLT CARD (continued)

The mesh for plotting current is controlled by input NY. NY is the number of mesh points in the y direction, for a plane, including the boundary. The corresponding number of mesh points, for the x direction, is calculated by the program. (NY = 2 + number of current arrows encountered when moving from YMIN to YMAX.)

The area covered by the current field plot may be selected in two ways. If the values XMIN, XMAX, YMIN, YMAX are left blank, the program determines the area to be plotted. The area is based on the maximum and minimum anchor point coordinates. The second method is to define XMIN, XMAX, YMIN, YMAX in terms of the x, y coordinate system. If there is only one anchor point XMIN, XMAX, YMIN, YMAX must be defined by the user. A star will be plotted at each anchor point within the defined area.

Examples of current field plots are shown in Figures 11 and 12.

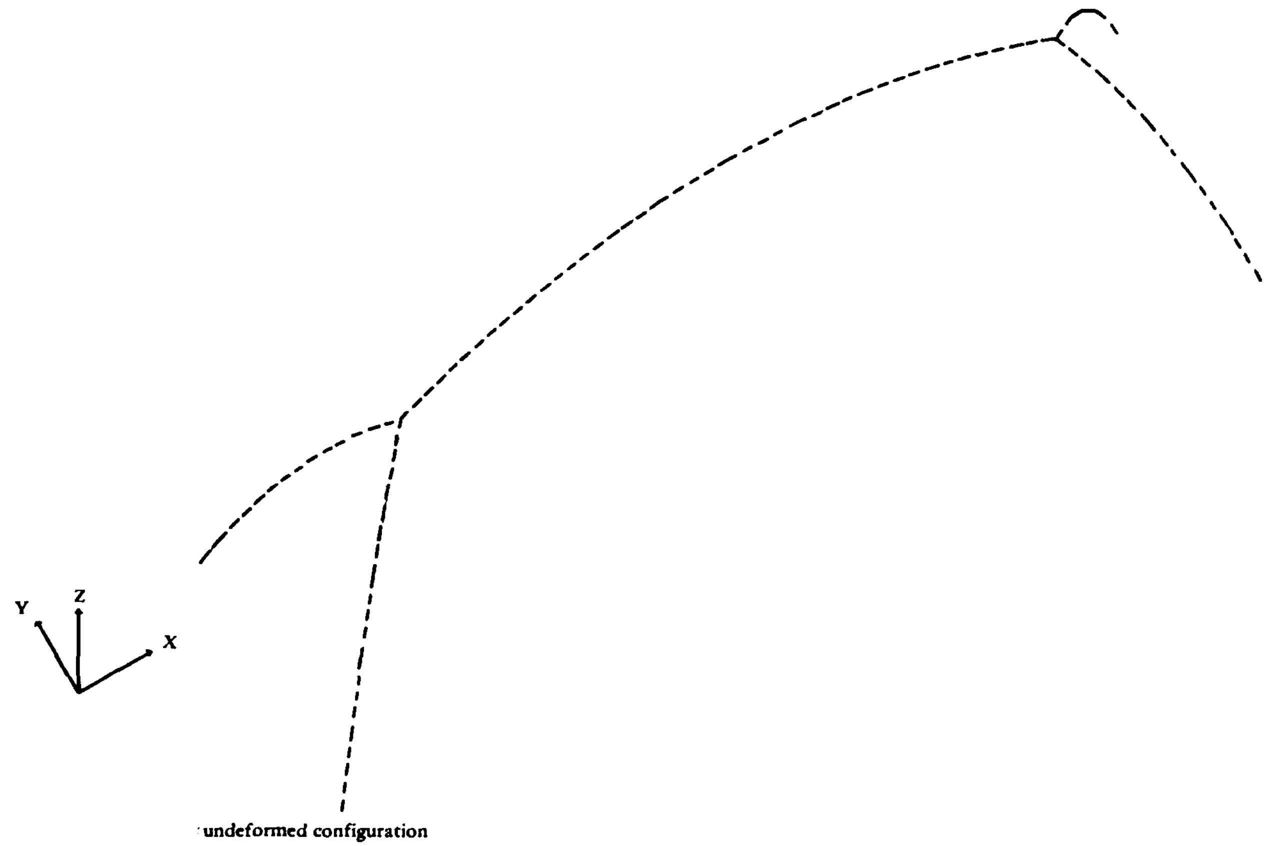


Figure 8. Perspective view of the undeformed structure (field 3 = 0).

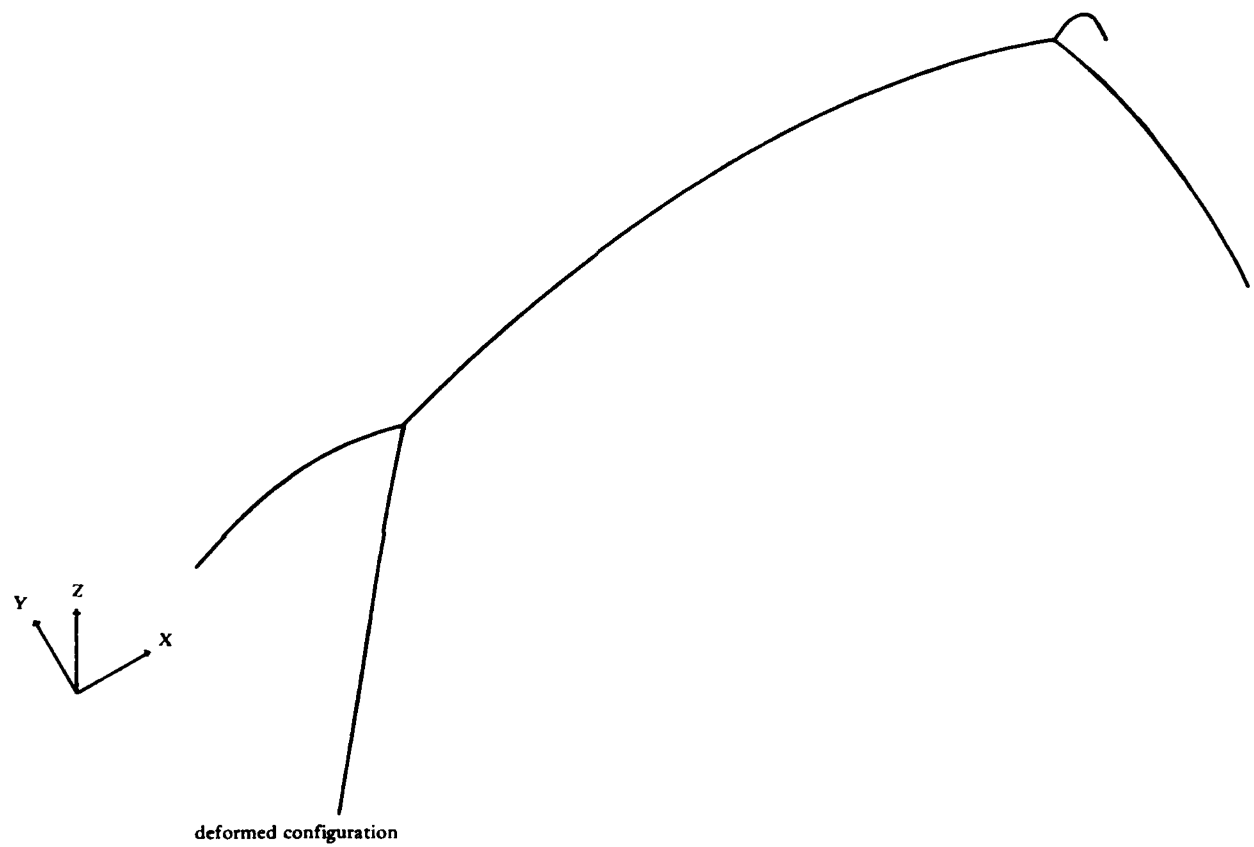


Figure 9. Perspective view of the deformed structure (field 3 = 1).

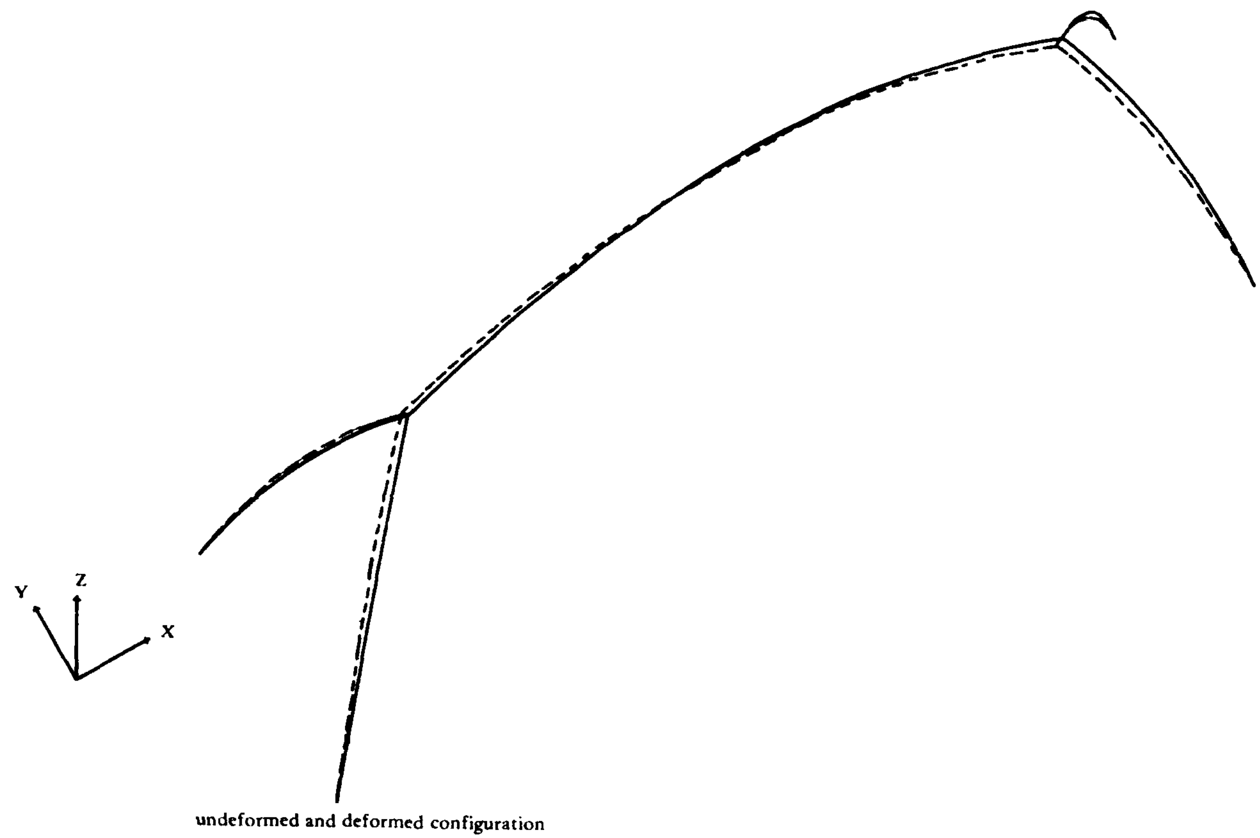


Figure 10. Perspective view of the deformed structure with the undeformed shape for comparison (field 3 = 2).

apply current profile at 45 dec increments

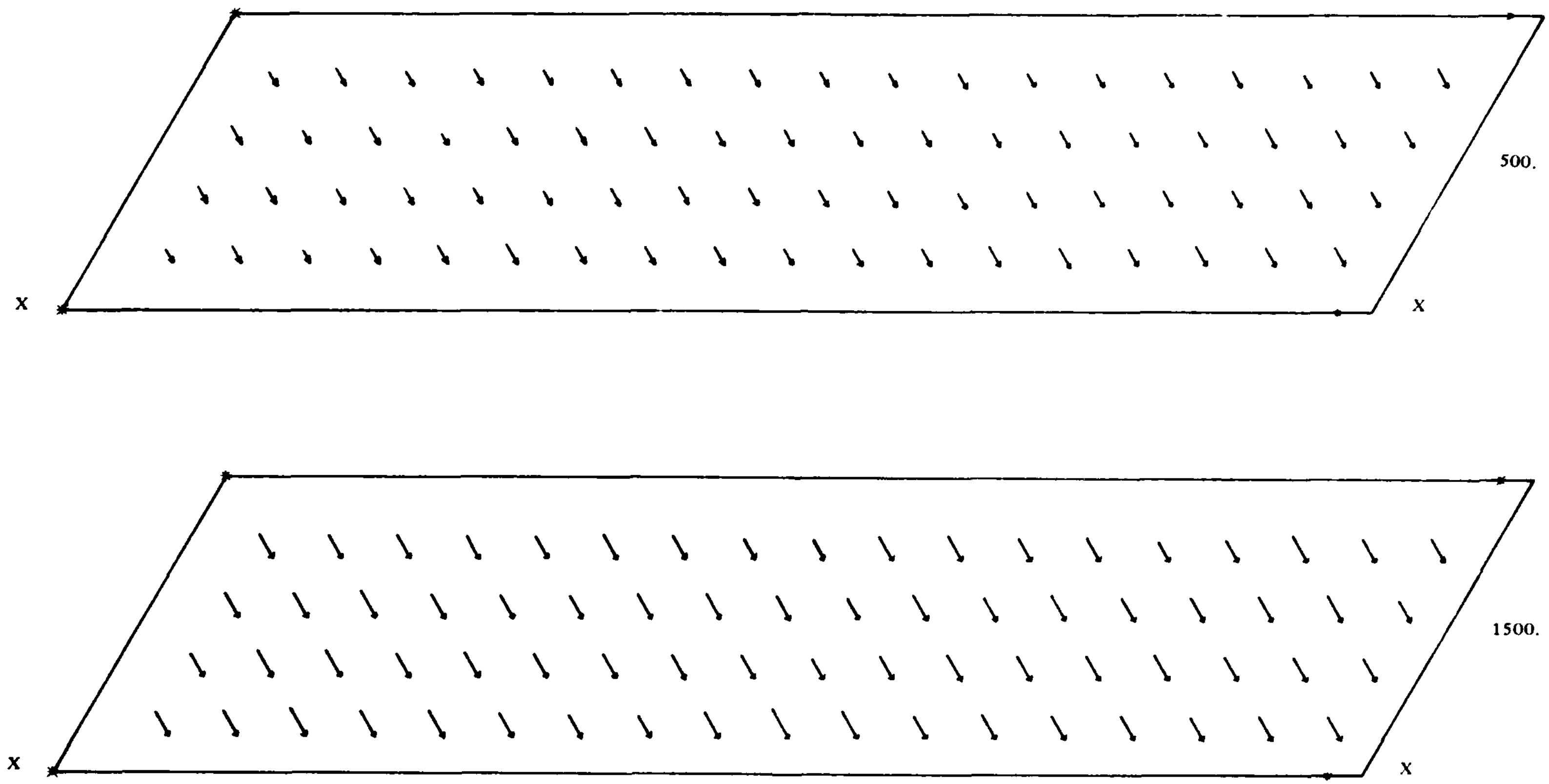


Figure 11. Unidirectional current field.

test for current option 3

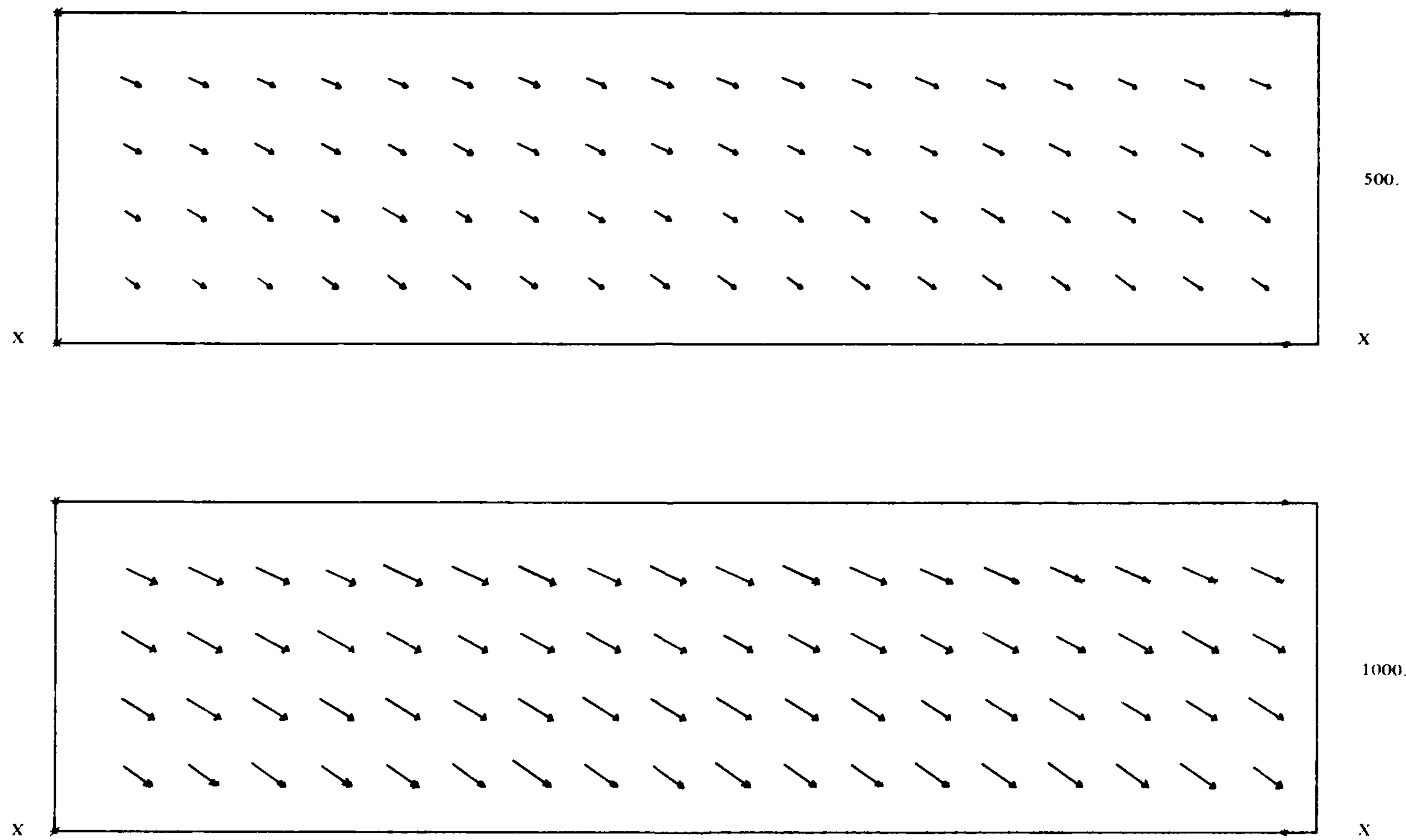


Figure 12. Non-unidirectional current field. (Note by sighting along the arrows that the field does curve.)

EOD CARD

Field	Columns	Format	Contents	Comments
1	1-4	I4	Card number (optional)	-999 to 9999
2	5-8	A4	^EOD	Right adjust
3	9-16		Not used	
4	17-24		Not used	
5	25-32		Not used	
6	33-40		Not used	
7	41-48		Not used	
8	49-56		Not used	
9	57-64		Not used	
10	65-72		Not used	
11	73-77		Not used	
12	78-80		Not used	

NOTE: The EOD card is used to specify the end of data transmission or end of a parametric case.

EOP CARD

Field	Columns	Format	Contents	Comments
1	1-4	I4	Card number (optional)	-999 to 9999
2	5-8	A4	‸EOP	Right adjust
3	9-16		Not used	
4	17-24		Not used	
5	25-32		Not used	
6	33-40		Not used	
7	41-48		Not used	
8	49-56		Not used	
9	57-64		Not used	
10	65-72		Not used	
11	73-77		Not used	
12	78-80		Not used	

NOTE: The EOP card is used to specify the end of the problem and is required for a normal termination.

Cable Array Source Deck

The cable array source deck contains all of the cards required to describe the physical characteristics of the cable array under consideration. The last card in the cable array source deck must be an EOD card to signify the end of data transmission. The form of the cable array source deck is given below.

Cable Array Source Deck

Card Type*	Comments
NJNC	One card
ANC	One for each array anchor
IR	One for each cut going from original to reduced array
CAB	One (plus one continuation card) for each array cable
DCAB	One for each discrete device attached to a cable
DJNC	One for each discrete device attached at a junction
DEN	One card
EOD	Must be last card in source deck

Cable Array Source Tape

The cable array source tape is an alternate means of transmitting to DECEL1 the physical characteristics of the cable array under consideration. A recommended program for generating the cable array source tape from the cable array source deck is given below.

Cable Array Source Tape Generation

```
  PRØGRAM STAPE
  DIMENSIØN DATA(10)
  DATA(IREAD = Unit number of card reader)
  DATA(ITAPE = Unit number of source tape)
1 READ(IREAD,10)(DATA(I),I=1,10),EX,NSEG
  WRITE(ITAPE,11)(DATA(I),I=1,10),EX,NSEG
  IF(DATA(2).NE.4HDCAB)GØ TØ 3
  READ(IREAD,20)TANDRG
  WRITE(ITAPE,21)TANDRG
```

(continued)

*These cards may be arbitrarily ordered except for the EOD card. It is strongly recommended that the cards in the cable array source deck be given unique card numbers (Field 1 of each card). Note that LUN, NDAT, COMP, VEL, ANG, and EOP cards are not permitted in the cable array source deck.

Cable Array Source Tape Generation (Continued)

```
  3 CONTINUE
    IF(DATA(2).EQ.4H EOD)GØ TØ 2
    GØ TØ 1
 10 FØRMAT(F4.0,A4,8F8.0,F5.0,I3)
 11 FØRMAT(F4.0,A4,8E15.8,/,E12.5,I3)
 20 FØRMAT(F8.0)
 21 FØRMAT(E15.8)
  2 REWIND TAPE
    END
```

Parametric Study Source Decks

The parametric study source decks are used to transmit to DECEL1 accuracy requirements, current fields, and changes in the physical properties of the cable array under consideration. Each parametric study source deck must begin with an NDAT card and a Parametric Descriptive Title card and end with an EOD card. The form of the parametric study source decks is given below.

Parametric Study Source Decks

Card Type*	Comments
NDAT	Must be first card in parametric study source deck. Field 3 (current option) can change as 0 1, 0 2, or 0 3. The changes 1 2, 1 3, and 2 3, even with intermediate zeros, are not permitted.
Parametric Title Card	NDAT card must be followed immediately by parametric title card.
COMP	Must appear after first NDAT card. The accuracy requirement transmitted is retained until the appearance of a COMP card in another parametric study source deck.
VEL	Must not appear after NDAT card containing current option 0. All VEL cards required to transmit a current profile must appear after the first NDAT card containing a current option 1 or 2 or 3. The current profile transmitted is retained until the appearance of a VEL card in another parametric study source deck. The appearance of the first VEL card in a parametric study source deck zeros the entire current profile. Thus, to change from one current profile to another, all VEL cards required to specify the new profile must appear in the appropriate parametric study source deck.
ANG	Must not appear after NDAT card containing current option 0. One ANG card must appear after the first NDAT card containing current option 1, 2 or 3. The current angles transmitted are retained until the appearance of an ANG card in another parametric study source deck.
ANC	Used to change anchor data. See Note.
CAB	Used to change cable data. See Note.
DCAB	Used to change discrete device on cable data. See Note.
DJNC	Used to change discrete device at junction data. See Note.
EOD	Must be last card in parametric study source deck.

*These cards may be arbitrarily ordered except for the NDAT, Parametric Title, and EOD cards. Note that LUN, JNC, IR, DEN, and EOP cards are not permitted in the parametric study source decks.

NOTE: The array design changes which are permitted are those changing the physical data of the array but not the overall geometric layout of, or the number of discrete devices on, the array. These changes are keyed by matching the <u>card number</u> and <u>type</u> appearing in a parametric study source deck to the <u>card number</u> and <u>type</u> appearing in changes in the array physical data is given below.

Summary of Changes in the Array Physical Data Permitted (P) and Not Permitted (NP)

Card Type	Field Number											
	1	2	3	4	5	6	7	8	9	10	11	12
ANC	NP	NP	NP	P	P	P	Not used					
CAB	NP	NP	NP	NP	NP	P	P	P	P	P	P	P
CONTINUATION CAB	P											
DCAB	NP	NP	NP	$1 \rightleftarrows 2$	NP	P	P	P	P	P	P	P
DJNC	NP	NP	NP	NP	NP	P	P	P	Not used			

OVERALL INPUT DECK

The overall input deck consists of a LUN card (optional) specifying the I/O options and the logical unit numbers of the required I/O devices, followed by the cable array source deck (or tape), followed by any number of parametric study source decks, and ended by an EOP card signifying the end of the problem. The form of the overall input deck is given below.

Overall Input Deck
- LUN Card (optional)
  Cable Array Source Deck (or Tape)
  Parametric Study Source Decks
- EOP Card

EXAMPLE

1. Compilation of cable array source deck errors only.

```
1000^LUN^^^^^^60^^^^^^61^^^^^^24 (or omit this card)
*****Main Title Card*****
     Cable Array Source Deck (or Tape)
1001^EOP
```

2. Deflections of the source deck cable array due to a current profile.

```
(LUN card omitted)
*****Main Title Card*****
     Cable Array Source Deck (or Tape)
1001NDAT^^^^^^^1
*****Parametric Study 1 Title Card*****
1002COMP
1003^VEL
1010^VEL
1011^ANG
1012^EOD
1013^EOP
```

3. Deflections of the source deck cable array due to a current profile and effects of buoyancy changes on these deflections.

```
(LUN card omitted)
*****MAIN TITLE CARD*****
Cable Array Source Deck (or Tape) containing a card:
^^^9DJNC^^^^^^^3^^^^^^^^^^^^^^^^10000.^^^^1.95^^^^35.3
1001NDAT^^^^^1
*****Parametric (see note) Study 1 Title Card*****
1002COMP
1003^VEL
1010^VEL
1011^ANG
1012^EOD
1013NDAT^^^^^^1
*****Parametric Study 2 Title Card*****
^^^9DJNC^^^^^^^3^^^^^^^^^^^^^^^^12500.^^^^1.95^^^^35.3
1014^EOD
1015^EOP
```

NOTE: In each case unique card numbers were assigned, otherwise an error would have resulted. However, any or all card numbers could have been omitted and no error would result.

ERROR MESSAGES

DECEL1 contains a series of internal error checks to insure that the original cable array is properly reduced to a statically determinate array; the input data are consistent; and the deck is properly structured.

If errors are found, the entire list of input cards is printed; and cards with errors are identified by an error code number. The text of the coded error message is printed after the card listing. All cards are scanned for errors; however, only the first error on a card is detected. A card with a DECEL1 detected error should be scanned visually to check for other errors.

DEFINITION OF ERRORS

Type 0 -
A type 0 error indicates that the card type identifier (Field 2) is not recognizable.

Type 1A - LUN
Field 6 not equal 0 or 1

Type 1B - LUN
Field 8 not equal 0,1,2

Type 1C - LUN
Non-unique numbers assigned to required I/O units.

Type 1A - NJNC
Field 3 greater than 44 or less than 2.

Type 1A - ANC
Field 3 greater than 44 or less than 1.

Type 1A - IR
Field 3 = Field 4.

Type 1B - IR
Fields 3 or 4 greater than 44 or less than 1.

Type 1A - CAB
Field 3 greater than 22 or less than 1.

Type 1B - CAB
Field 4 = Field 5.

Type 1C - CAB
Fields 4 or 5 greater than 44 or less than 1.

Type 1D - CAB
Fields 7, 8 or 9 less than or equal to 0.

Type 1E - CAB
Fields 10 or 11 less than 0

Type 1F - CAB
Field 10=0 and Field 11 not equal 0

Type 1G - CAB
Field 10 not equal 0 and Field 11=0.

Type 1H - CAB
Field 12 greater than 50 or less than 1.

Type 1A - DCAB
Field 3 greater than 22 or less than 1.

Type 1B - DCAB
Field 4 greater than 2 or less than 1.

Type 1C - DCAB
Field 5 greater than 1000 or less than 1.

Type 1D - DCAB
Field 4=1 and Field 9 less than or equal to 0.

Type 1E - DCAB
Field 4=2 and Field 9 not equal 0.

Type 1F - DCAB
Fields 7,8 or 10 less than 0.

Type 1A - DJNC
Field 3 greater than 44 or less than 1.

Type 1B - DJNC
Field 7 or 8 less than 0.

Type 1A - DEN
Field 3 less than 0.

Type 1A - NDAT
Field 3 not equal 0,1, or 2.

Type 1A - COMP
Field 3 less than or equal 0.

Type 1A - ANG
Field 4 less than or equal 0.

Type 1B - ANG
Field 5 less than Field 3.

Type 2A - ANC
The junction number assigned to the anchor (Field 3) has been assigned to a preceding ANC card or to an S=L junction (Field 5) on a preceding CAB card.

Type 2A - CAB
The junction number assigned to the S=L junction (Field 5) has been assigned on a preceding CAB card or to an anchor junction (Field 3) on a preceding ANC card.

Type 3 - CAB
A Type 3 error appears only in conjunction with a CAB card and indicates that the number assigned to the cable (Field 3) has been assigned on a preceding CAB card.

Type 4A - IR
The junction number assigned in Field 3 has been assigned in Fields 3 or 4 of a preceding IR card.

Type 4B - IR
The junction number assigned in Field 4 has been assigned in Field 3 of a preceding IR card.

Type 6A - NJNC
An NJNC card has previously appeared in the particular source deck.

Type 6A - DEN
A DEN card has previously appeared in the particular source deck.

Type 6A - COMP
A COMP card has previously appeared in the particular source deck.

Type 6A - VEL
Twenty-five VEL cards have previously appeared in the particular source deck.

Type 6B - VEL
The Z-coordinate at which the current velocity is specified (Field 3) has been used on a preceding VEL card in the particular source deck.

Type 7 -
A Type 7 error indicates an inadequacy of information in cable array source deck (or tape). The other information column under the error heading contains a 1x3 matrix, the elements of which give respectively the number of NJNC cards read, the number of DEN cards read, and the number of ANC cards read. A zero element is an error (see cable array source deck).

Type 8 -
A Type 8 error indicates a discontinuity in numbering the cables in the array. The other information column under the error heading contains a 1x22 matrix, the elements of which contain one or zero indicating, respectively, the use or non-use of the corresponding column number as a cable number. Zeros interspersed with ones are in error (see array description).

Type 9 -
A Type 9 error indicates a discontinuity in numbering the junctions in the array. The other information column under the error heading contains a 1x44 matrix, the elements of which contain one or zero indicating respectively, the use or non-use of the corresponding column number as a junction number. Zeros interspersed with ones are in error (see array description and reduction to a statically determinate array).

Type 11 -
A Type 11 error indicates an improper reduction of the original cable array to a statically determinate array or an absence of certain input cards in the cable array source deck (or tape). The other information column

under the error heading contains a 1x5 matrix, the elements of which give, respectively, the number of CAB cards read, the number of ANC cards read, the number of junctions in the original cable array (Field 3 of the NJNC card), the number of required cuts (Eq. (1)) calculated from the preceding information, and the number of IR cards read. Column 5 not equal to column 4 is an error (see reduction to a statically determinate array).

Type 12A - IR
The junction number assigned in Field 3 is less than or equal to the number of junctions in the original (unreduced) array (Field 3 of the NJNC card).

Type 12B - IR
The junction number assigned in Field 3 is greater than the number of junctions in the original (unreduced) array plus the number of cuts made in reducing the array (Eq. (1)).

Type 12C - IR
The junction number assigned in Field 4 is greater than the number of junctions in the original (unreduced) array.

Type 12A - CAB
The junction number assigned in Field 4 is greater than the number of junctions in the original (unreduced) array (Field 3 of the NJNC card) plus the number of cuts made in reducing the array (Eq. (1)).

Type 12A - DCAB
The cable number assigned in Field 3 does not correspond to a cable number assigned to a cable (Field 3 of the CAB cards).

Type 12B - DCAB
The distance of the discrete device from the S=0 junction of the cable (Field 10) is greater than or equal to the length of the corresponding cable (Field 9 of the CAB card).

Type 12A - DJNC
The junction number assigned in Field 3 does not correspond to either a junction number assigned to an anchor (Field 3 or the ANC cards) or a junction number assigned to an S=L junction of a cable (Field 5 of the CAB cards).

Type 13 -
A Type 13 error indicates that the original cable array has not been properly reduced to a statically determinate array or that junctions have been improperly numbered. The other information column under the error heading contains the message, improper array reduction or junction numbering. Check tree representation of array (see array reduction section of Users Manual) against junction numbering on ANC and CAB cards.

Type 14A -

A Type 14 error indicates an inadequacy of information in a parametric study source deck. The other information column under the error heading contains a 1x5 matrix, the elements of which give, respectively, the number of COMP cards read, the current field option, the number of VEL cards read, the number of VEL cards containing a Z-coordinate (Field 3) less than or equal to the minimum Z-coordinate transmitted by the ANC cards (Field 6 of the ANC cards), and the number of ANG cards read. If column 1 contains a zero, then a COMP card has not appeared after the first NDAT card (see parametric study source decks).

Type 14B -

A Type 14 error indicates an inadequacy of information in a parametric study source deck. The other information column under the error heading contains a 1x5 matrix, the elements of which give, respectively, the number of COMP cards less than or equal to the minimum Z-coordinate transmitted by the ANC cards (Field 6 of the ANC cards), and the number of ANG cards read. If column 2 contains a one and any of columns 3, 4 or 5 contain a zero, then the standard current field has not been properly formulated (see parametric study source decks and standard current field).

Type 15 -

A Type 15 error indicates than an unpermitted change has been attempted in a parametric study source deck. (See parametric study source decks.)

Type 16 -

A Type 16 error indicates an improper deck structure. See cable array source deck, parametric study source decks, and overall input deck.

Type 17 -

A Type 17 error indicates that the cable array source deck (or tape) contains more than 2150 records. The other information column under the error heading contains the message common/B1/bounds exceeded. See Users Manual. A Type 17 error is readily correctable if the machine being used has sufficient core storage. This correction is achieved by changing the row dimension of DATAT on cards DES025 and INF022 from 2150 to a number exceeding the number of records in the cable array source deck (or tape). Simultaneously the comparison value on card INP615 must be changed from 2150 to the new row dimension of DATAT.

Type 18 -

A Type 18 error indicates that the accuracy required for the array equilibrium calculations (Field 3 of the COMP card) has not been obtained during the calculations. This is for one of two possible reasons.

A. Some cable segments have gone slack (that is, the segments have near zero tension. An examination of the tensions printed out in conjunction with a Type 18 error will reveal if this is the reason. If it is, see the section on statically unstable cable arrays in Reference 2 for possible remedial actions. If it is not then ...

B. The accuracy required for the equilibrium calculations is simply too stringent for the computer to handle (see COMP card). An examination of the final value of the accuracy obtained, printed out in conjunction with a Type 18 error, will reveal the best accuracy obtainable. Field 3 of the COMP card should be modified to reflect this information.

ARRAY DESCRIPTIVE OUTPUT

Following each error-free reading of a parametric study source deck, DECEL1 transmits to the line printer a description of the physical characteristics of the cable array under study. This printout includes anchor junctions and locations, information concerning the reduction of the original cable array to a statically determine array, properties of the cables in the array, properties of the discrete devices located at array junctions total number of Type 1 and 2 devices, current field option and current profile and calculational accuracy requirements.

The format of the array descriptive output is self-explanatory. A sample printout is given in Appendix A.

STRUCTURAL OUTPUT

If output option 0 or 2 is selected, DECEL1 transmits to the line printer a structural output. The structural printout follows and refers to the array characterized in the array descriptive output and contains information giving:

a. A description of the current field (i.e., no current or current from xxx degrees)

b. The cable forces and angles at each anchor

c. The position coordinates of the original (unreduced) array junctions, the displacement of these coordinates from the no-current coordinates, and the cable forces and angles at each junction

d. The maximum and minimum tensions and their locations for each array cable and the maximum displacement from the no-current condition and its location for each cable

e. The position coordinates, the displacement of these coordinates from the no-current coordinates, and the tension at each Type 1 and 2 DCAB device in the array

This latter information is printed out in the same order that the Type 1 and 2 DCAB devices are numbered. Note that it is possible to obtain the latter information for any point on any cable in the array by defining a "dummy" Type 2 DCAB device to be located at the point. A dummy Type 2 DCAB device is simply one for which fields 6, 7, and 8 of the DCAB card are left blank so that the "device" has no effect on the array equilibrium calculations.

The format of the structural output is self-explanatory. A sample printout is given in Appendix A (Figure 17).

DEVICE LOCATION OUTPUT

If output option 1 or 2 is selected, DECEL1 transmits to tape or cards a device location output. The device location output contains information giving:

1. A description of the current field (i.e., no current or current from xxx degrees)
2. The position coordinates of each Type 1 and 2 discrete device in the array

Four types of records are associated with the device location output. Each of these records is written with the format:

(A4,I4,3F10.2)

REC Record

Field	Format	Contents
1	A4	˰REC
2	I4	Record number
3	F10.2	Not used
4	F10.2	Not used
5	F10.2	Not used

NOTE: The REC record is used to identify the cable array under study. The record number (Field 2) is referenced in the array descriptive output in the statement, "DEVICE LOCATION OUTPUT RECORD XX REFERS TO THIS ARRAY." The information following a REC record refers to the identified array.

CUR Record

Field	Format	Contents
1	A4	˰CUR
2	I4	0 if no current acting on array 1 if current is acting on array
3	F10.2	Blank if Field 2 = 0 Current angle if Field 2 = 1
4	F10.2	Not used
5	F10.2	Not used

NOTE: The CUR record is used to describe the current field (i.e., no current or current from xxx degrees). The information following a CUR record refers to the identified current field.

DEV Record

Field	Format	Contents
1	A4	‸DEV
2	I4	Discrete device index (Field 5 of the DCAB and DJNC cards)
3	F10.2	X coordinate of device
4	F10.2	Y coordinate of device
5	F10.2	Z coordinate of device

NOTE: The DEV records are used to transmit the position coordinates of the Type 1 and 2 discrete devices in the array. There is one DEV record for each indexed (Types 1 and 2) device for each identified current field.

EOP Record

Field	Format	Contents
1	A4	‸EOP
2	I4	Not used
3	F10.2	Not used
4	F10.2	Not used
5	F10.2	Not used

NOTE: The EOP record is used to signify the end of output transmission.

A typical overall device location output file is illustrated below.

```
^REC^^^1
^CUR^^^0
    DEV Records (one for each indexed device)
^CUR^^^1 current angle
    DEV Records
^CUR^^^1 current angle
    DEV Records
^REC^^^2
^CUR^^^0
    DEV Records
^EOP
```

REFERENCES

1. Naval Research Laboratory Report 6819, The static equilibrium configuration of cable arrays by use of the method of imaginary reactions, R. A. Skop, and G. J. O'Hara, Port Hueneme, Calif., Feb 1969.

2. Naval Research Laboratory Report 7296, The analysis of internally redundant structural cable arrays, by R. A. Skop, and G. J. O'Hara, Port Hueneme, Calif., Sept 1971.

3. Naval Research Laboratory Report 6894, The static configuration of a tri-moored, subsurface, buoy-cable array acted on by current-induced forces, by R. A. Skop, and R. E. Kaplan, Port Hueneme, Calif., May 1969.

4. R. A. Skop, "The method of imaginary reactions: applications to N-point moors," Marine Technology, 1970, Preprints of 6th Annual Marine Technology Society Conference, June 29-July 1, 1970, Vol. 1, Washington, D.C., pp. 1-22.

5. M. J. Casarella, and M. Parsons, (1970), "Cable systems under hydrodynamic loading," Marine Technology Society Journal 4 (No. 4), July-Aug 1970, p. 2744.

6. B. W. Wilson, "Elastic Characteristics of Moorings," Waterways and Harbors Div., ASCE, (Nov 1967), 93 (No. WW4), pp. 27-56.

7. Civil Engineer Laboratory, Technical Report R-848, Seafloor construction experiment, SEACON II - an instrument tri-moor for evaluating undersea cable structure technology by T. R. Kretschmer, G. A. Edgerton, and N. D. Albertsen, Port Hueneme, Calif., Dec 1976.

Appendix A

EXAMPLE PROBLEM

An example problem has been included both to illustrate actual input and output and as a test case. The test case can be used to confirm proper operation of DECEL1 when implemented on a particular host computer. The test case structure is shown in Figure 13. The structure represents an acoustic array in the horizontal leg; this leg has been buoyed at the center to keep it approximately horizontal. A signal cable rises from one anchor to a subsurface buoy. The applied current is unidirectional with the profile shown in Figure 14. The current is acting broadside to the structure. The DECEL1 model of the structure is shown in Figure 15; other details of the modeling are shown in Tables 4 through 8.

Input card images are shown in Figure 16. Note that one dummy-DCAB-device card was intentionally placed "out of sequence" just after the NJNC card. This illustrates that the card sequence is essentially arbitrary, except as noted elsewhere in the manual.

The output from DECEL1 is shown in Figures 17 and 18. Note that the "number of indexed devices" count includes the three DJNC devices. The "Array Equilibrium with no Current" portion defines both the initial positions of devices and the properties of the DCAB devices. If the "do not print" flag had been set on any DCAB card, that device would not have been tabulated here; however, its effects would have been accounted for in the solution.

In the portion of the output where the current was applied (Figure 18), the displacement of all junctions and devices is listed relative to the present no-current position and relative to the original no-current case. In this case both displacements are identical since the new no-current reference flag had not been set on the NDAT card.

Figure 19 shows the configuration of the array both in the no-current condition (dotted lines) and with current applied (solid lines). For this plot the default perspective view angles were used. Other views (plan or elevation) of the same structure in the same current could be obtained by additional identical NDAT cases with the perspective plotting angles changed accordingly.

Table 4. Cables

Cable No.	Junction		Length (ft)	Weight/ Foot (lb/ft)	Diameter (in.)	Drag Coefficient
	From	To				
1	1	2	3,000	0.25	1.0	1.4
2	2	8	3,000	0.25	1.0	1.4
3	2	4	5,000	0.20	0.75	1.4
4	4	9	3,000	0.25	1.0	1.4
5	4	10	3,000	0.25	1.0	1.4
6	9	7	4,000	0.3	1.25	1.4

Table 5. Anchor Locations

Anchor No.	Junction No.	x	y	z
1	1	0	1,000	0
2	3	0	-1,000	0
3	5	7,000	-1,000	0
4	6	7,000	1,000	0

Table 6. Imaginary Reaction Cuts

Junction No.	Cut No.
3	8
5	9
6	10

Note: In the model the cables terminate at cuts rather than at anchors.

Table 7. DJNC Devices

Device Junction No.	Device Buoyancy (lb)	Device Drag Coefficient	Device Frontal Area (ft^2)
2	3,000	1.0	26.0
4	3,000	1.0	26.0
7	3,000	1.0	26.0

Table 8. DCAB Devices

Device Index	On Cable No.	S Coordinate (ft)	Device Buoyancy (lb)
9	3	2,500	1,000

Note: Other dummy devices are used to obtain a printout of the spatial location of the device; these devices have not been tabulated here. Dummy devices have a very small weight and no drag.

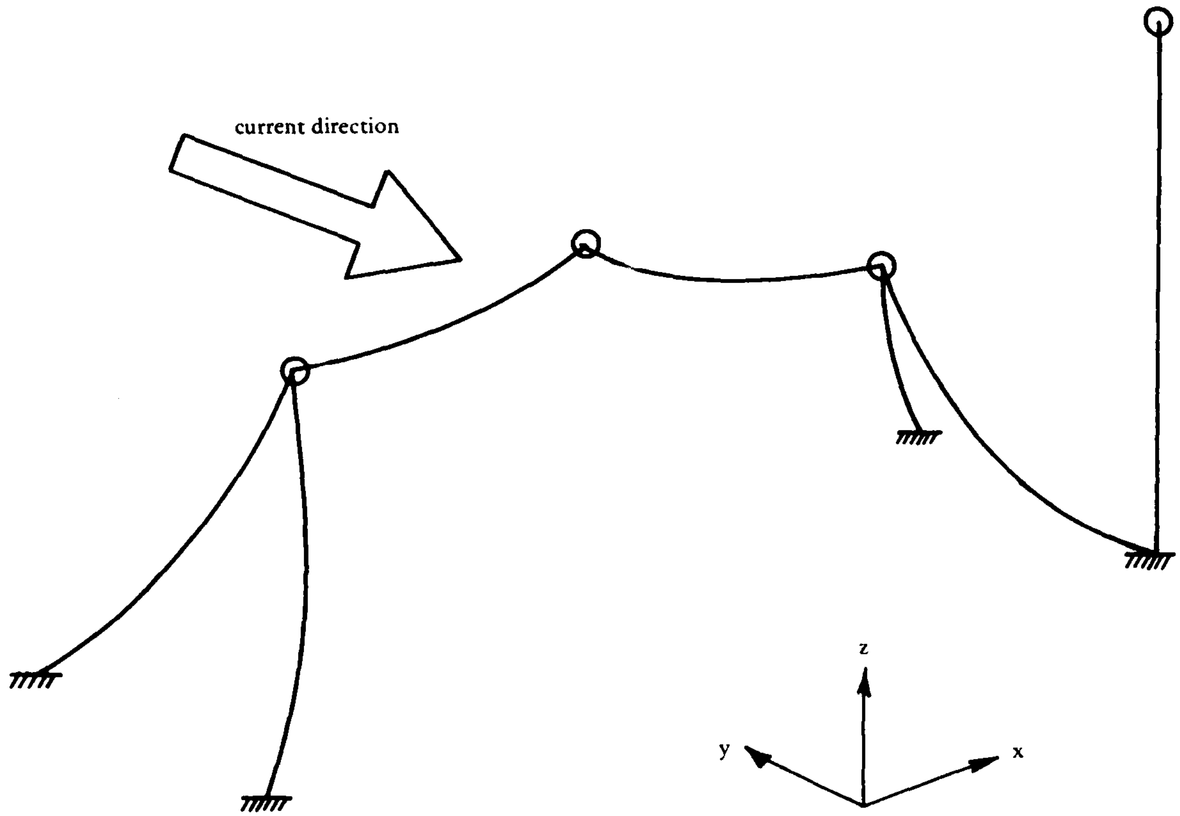


Figure 13. DECEL1 test case sturcture.

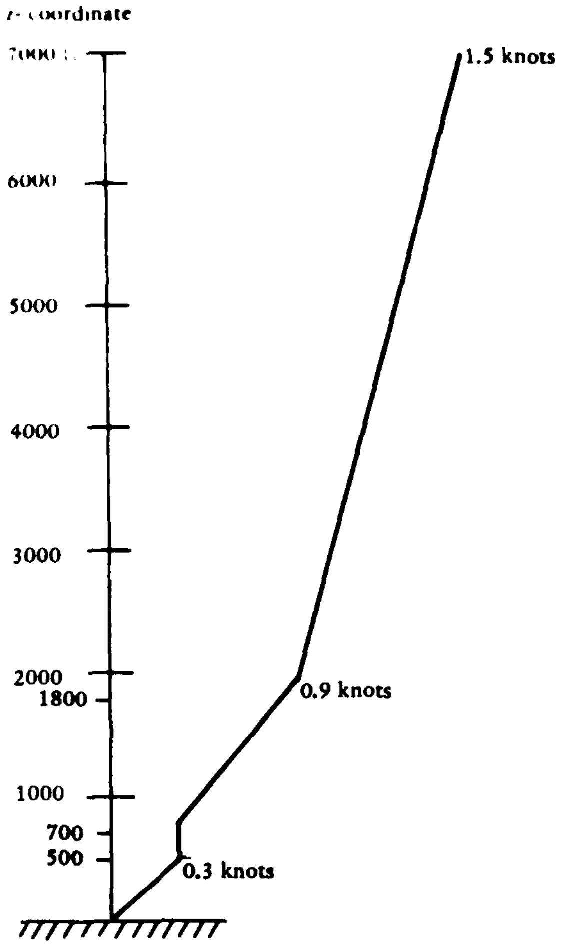


Figure 14. Current profile.

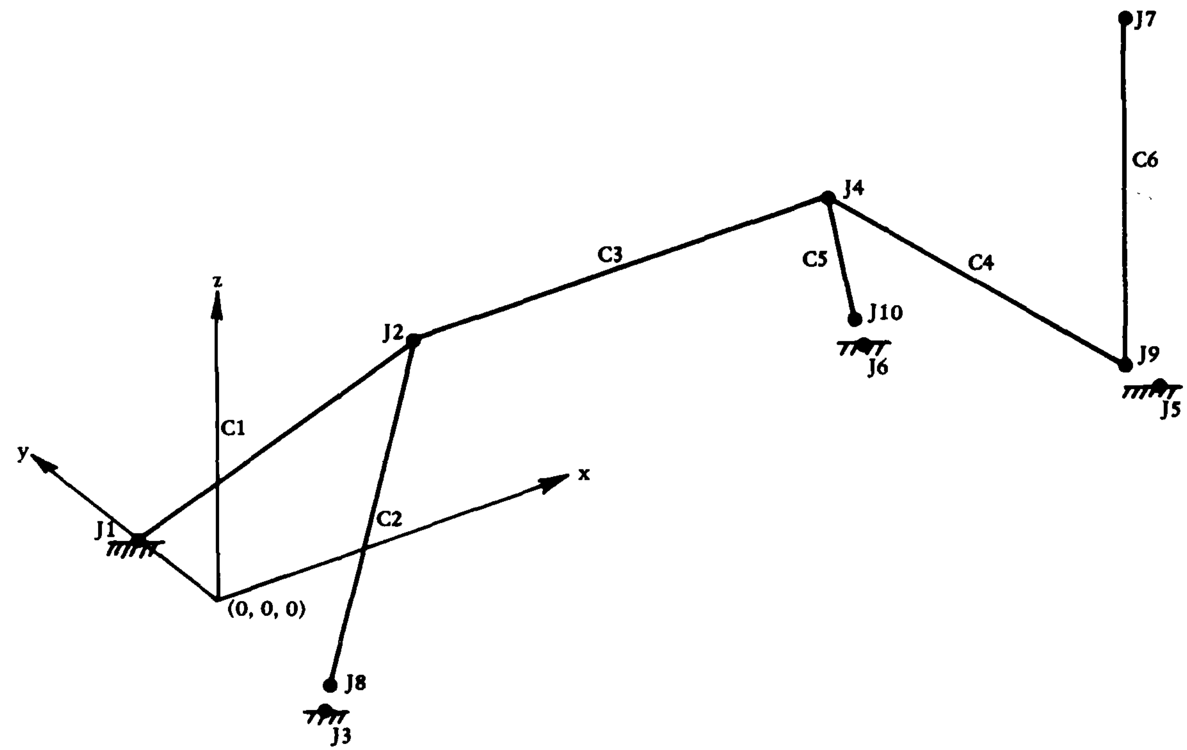


Figure 15. DECEL1 test case structure model.

```
DECFLT TEST CASE
   NJNC        7
   DCAB        1        2                0.001                 0.01               750.
    ANC        1      0.0    1000.         0.0
    ANC        3      0.0   -1000.         0.0
    ANC        5   7000.0   -1000.         0.0
    ANC        6    7000.    1000.         0.0
     IR        8        3
     IR        9        5
     IR       10        6
    CAB        1        1        2       -0.25        1.4       1.0    3000.              50
   0.03
    CAB        2        2        8       -0.25        1.4       1.0    3000.              50
   0.03
    CAB        3        2        4       -0.20        1.4      0.75    5000.              50
   0.03
    CAB        4        4        9       -0.25        1.4       1.0    3000.              50
   0.03
    CAB        5        4       10       -0.25        1.4       1.0    3000.              50
   0.03
    CAB        6        9        7       -0.30        1.4      1.25    4000.              50
   0.03
   DCAB        1        2                0.001                 0.01               1500.
   DCAB        1        2                0.001                 0.01               2250.
   DCAB        2        2                0.001                 0.01               750.
   DCAB        2        2                0.001                 0.01               1500.
   DCAB        2        2                0.001                 0.01               2250.
   DCAB        3        2                 0.01                   .1               1000.
   DCAB        3        2                 0.01                   .1               2000.
   DCAB        3        2                1000.         1.         5.               2500.
   DCAB        3        2                 0.01                   .1               3000.
   DCAB        3        2                 0.01                   .1               4000.
   DCAB        4        2                0.001                 0.01               750.
   DCAB        4        2                0.001                 0.01               1500.
   DCAB        4        2                0.001                 0.01               2250.
   DCAB        5        2                0.001                 0.01               750.
   DCAB        5        2                0.001                 0.01               1500.
   DCAB        5        2                0.001                 0.01               2250.
   DCAB        6        2                0.001                 0.01               1000.
   DCAB        6        2                0.001                 0.01               2000.
   DCAB        6        2                0.001                 0.01               3000.
   DJNC        2                         3000.        1.0       26.
   DJNC        4                         3000.        1.0       26.
   DJNC        7                         3000.        1.0       26.
    DEN     1.99
    EOD
   NDAT        1
APPLY 90 DEGREE CURRENT (TOWARD -Y AXIS)
   COMP      0.1
    VEL      0.0      0.0
    VEL    500.0      0.3
    VEL    700.0      0.3
    VEL   1800.0      0.9
    VEL   7000.0      1.5
    ANG      90.       1.      90.
   PPLT        2
    ECD
    ECP
```

Figure 16. Input card images.

DECEL1 UPDATE INFORMATION
========================

THIS IS THE JANUARY 1980 VERSION OF DECEL1 AS DESCRIBED IN THE USERS MANUAL
NO UPDATES HAVE BEEN ADDED

NO ERRORS DETECTED

DECEL1 TEST CASE

APPLY 90 DEGREE CURRENT (TOWARD -Y AXIS)

PHYSICAL CHARACTERISTICS OF THE STRUCTURAL CABLE ARRAY

PHI= 0.00

SINCE PHI=0, THE MAGNETIC AND ARRAY REFERENCED COORDINATE SYSTEMS ARE IDENTICAL.

ALL X,Y,Z RESULTS AND DISPLACEMENTS ARE GIVEN IN TERMS OF THE ARRAY FIXED COORDINATE SYSTEM.

NO. OF ANCHORS IS 4

JUNCTION NO.	X-COORDINATE	Y-COORDINATE	Z-COORDINATE
1	0.00	1000.00	0.00
3	0.00	-1000.00	0.00
5	7000.00	-1000.00	0.00
6	7000.00	1000.00	0.00

NO. OF JUNCTIONS IN ORIGINAL ARRAY IS 7

NO. OF CUTS MADE IN ORIGINAL ARRAY IS 3

JUNCTION NO. OF CUT	JUNCTION NO. AT WHICH CUT MADE
8	3
9	5
10	6

Figure 17. Output from DECEL1 for the example problem.

NO. OF CABLES IS 6

CABLE NO.	S=0 JUNC	S=L JUNC	LENGTH	DIAMETER	WEIGHT/LENGTH	NORM DRAG COEFFICIENT	RIGIDITY	CONSTITUTIVE EXPONENT	NO. OF ELEMENTS	TANG DRAG COEFFICIENT
1	1	2	3000.00	1.000	-.250	1.400	0.	0.000	50	.030
2	2	8	3000.00	1.000	-.250	1.400	0.	0.000	50	.030
3	2	4	5000.00	.750	-.200	1.400	0.	0.000	50	.030
4	4	9	3000.00	1.000	-.250	1.400	0.	0.000	50	.030
5	4	10	3000.00	1.000	-.250	1.400	0.	0.000	50	.030
6	9	7	4000.00	1.250	-.300	1.400	0.	0.000	50	.030

PROPERTIES OF THE DEVICES LOCATED AT JUNCTIONS ARE AS FOLLOWS

DEVICE JUNC. NO.	DEVICE WEIGHT	DEVICE DRAG COEFFICIENT	DEVICE FRONTAL AREA
2	3000.00	1.000	26.00
4	3000.00	1.000	26.00
7	3000.00	1.000	26.00

TOTAL NO. OF TRACKED DEVICES IS [illegible]

ACCURACY REQUIRED IN CALCULATIONS IS .1000
DECEL1 TEST CASE

ARRAY EQUILIBRIUM WITH NO CURRENT

ARRAY ANCHORS
----- -------

JUNC. NO. OF ANCHOR	CABLE AT ANCHOR	TENSION AT ANCHOR	FORCE COMPONENTS AT ANCHOR X-COMP	Y-COMP	Z-COMP	HOR.-COMP	CABLE ANGLES WRT X-AXIS	XY-PLANE
1	1	974.87	466.84	-420.50	745.39	628.30	-42.01	49.87
3	2	974.89	466.85	420.50	745.41	628.31	42.01	49.87
5	4	983.22	-466.83	423.53	754.60	630.33	137.78	50.13
6	5	983.28	-466.86	-423.53	754.65	630.35	-137.79	50.13

ARRAY CABLES
----- ------

CABLE NO.	MAXIMUM TENSION	S-COORD OF	MINIMUM TENSION	S-COORD OF
1	1622.02	3000.00	974.87	0.00
2	1622.04	0.00	974.89	3000.00
3	1054.82	2500.00	933.69	46.01
4	1631.29	0.00	983.22	3000.00
5	1631.35	0.00	983.28	3000.00
6	3000.00	4000.00	1800.00	0.00

Figure 17. Continued.

ARRAY JUNCTIONS

JUNC. NO.	CABLE AT JUNCTION	TENSION AT JUNCTION	CABLE ANGLES WRT X-AXIS	CABLE ANGLES WRT XY-PLANE	JUNCTION LOCATION X-COORD	JUNCTION LOCATION Y-COORD	JUNCTION LOCATION Z-COORD
2	1	1622.02	137.99	-67.21	1110.22	-.00	2588.59
2	2	1622.04	-137.99	-67.21			
2	3	933.74	.00	-.56			
4	3	933.74	-180.00	.57	5897.72	.02	2592.27
4	4	1631.29	-42.22	-67.27			
4	5	1631.35	42.21	-67.27			
7	6	3000.00	0.00	-90.00	7000.00	-1000.00	4000.01

INDEXED DEVICES ALONG ARRAY CABLES

DEVICE INDEX	CABLE NO.	S COORDINATE	TENSION AT DEVICE	DEVICE LOCATION X-COORD	DEVICE LOCATION Y-COORD	DEVICE LOCATION Z-COORD	DEVICE WEIGHT	DEVICE LENGTH	NORMAL DRAG CO	TANG DRAG CO
1	1	750.00	1124.74	334.42	698.78	599.49	.00	0.00	0.000	0.000
2	1	1500.00	1284.54	625.66	436.45	1238.66	.00	0.00	0.000	0.000
3	1	2250.00	1450.98	882.06	205.51	1904.42	.00	0.00	0.000	0.000
4	2	750.00	1451.00	882.06	-205.51	1904.42	.00	0.00	0.000	0.000
5	2	1500.00	1284.56	625.66	-436.45	1238.66	.00	0.00	0.000	0.000
6	2	2250.00	1124.76	334.41	-698.79	599.49	.00	0.00	0.000	0.000
7	3	1000.00	952.99	2103.66	.00	2684.83	.01	0.00	0.000	0.000
8	3	2000.00	1012.17	3057.19	.01	2980.75	.01	0.00	0.000	0.000
9	3	2500.00	1054.62	3509.25	.01	3193.98	1000.00	0.00	1.000	0.000
10	3	3000.00	1019.43	3958.20	.01	3020.73	.01	0.00	0.000	0.000
11	3	4000.00	956.85	4906.32	.01	2707.82	.01	0.00	0.000	0.000
12	4	750.00	1460.15	6124.52	-205.74	1907.72	.00	0.00	0.000	0.000
13	4	1500.00	1293.56	6379.21	-436.80	1241.34	.00	0.00	0.000	0.000
14	4	2250.00	1133.51	6666.31	-699.08	601.17	.00	0.00	0.000	0.000
15	5	750.00	1460.21	6124.52	205.77	1907.72	.00	0.00	0.000	0.000
16	5	1500.00	1293.61	6379.21	436.82	1241.34	.00	0.00	0.000	0.000
17	5	2250.00	1133.57	6668.31	699.09	601.16	.00	0.00	0.000	0.000
18	6	1000.00	2100.00	7000.00	-1000.00	1000.01	.00	0.00	0.000	0.000
19	6	2000.00	2400.00	7000.00	-1000.00	2000.01	.00	0.00	0.000	0.000
20	6	3000.00	2700.00	7000.00	-1000.00	3000.01	.00	0.00	0.000	0.000

Figure 17. Continued.

DECEL1 TEST CASE

APPLY 90 DEGREE CURRENT (TOWARD -Y AXIS)

NUMBER OF ITERATIONS FOR CONVERGENCE - 12

CURRENT FIELD OPTION IS 1

Z-COORDINATE OF CURRENT (FEET)	MAGNITUDE OF CURRENT AT Z (KNOTS)	DIRECTION OF CURRENT AT Z FROM N-AXIS (DEGREES)
0.00	0.000	0.000
500.00	.300	0.000
700.00	.300	0.000
1000.00	.900	0.000
7000.00	1.500	0.000

*****CURRENT DIRECTION IS POSITIVE IN THE CLOCKWISE SENSE FROM THE N-AXIS*****

ARRAY EQUILIBRIUM WITH 270.00 DEGREE CURRENT

ARRAY EQUILIBRIUM WITH CURRENT DIRECTION
270.00 DEGREES FROM X-AXIS(+ IS COUNTERCLOCKWISE)
90.00 DEGREES FROM N-AXIS(+ IS CLOCKWISE)

ARRAY ANCHORS
----- -------

JUNC. NO. OF ANCHOR	CABLE AT ANCHOR	TENSION AT ANCHOR	FORCE COMPONENTS AT ANCHOR X-COMP	Y-COMP	Z-COMP	HOR.-COMP	CABLE ANGLES WRT X-AXIS	XY-PLANE
1	1	2120.84	921.12	-1197.18	1488.71	1510.53	-52.42	44.58
3	2	105.56	93.45	15.88	-46.45	94.79	9.64	-26.10
5	4	104.64	-92.76	15.83	-45.78	94.10	170.32	-25.94
6	5	2135.04	-921.38	-1202.57	1504.41	1514.96	-127.46	44.80

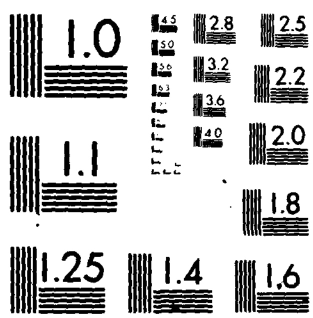
ARRAY CABLES
----- ------

CABLE NO.	MAXIMUM TENSION	S-COORD CF	MINIMUM TENSION	S-COORD CF	MAXIMUM DISP.	S-COORD CF	LOCATION OF THIS POINT X-COORD	Y-COORD	Z-COORD	NO CURRENT LOC. OF THIS POINT X-COORD	Y-COORD	Z-COORD
1	2704.86	3000.00	2120.84	0.00	486.17	3000.00	1172.55	-421.42	2354.31	1110.22	-.00	2588.59
2	696.39	0.00	94.79	2814.21	576.02	970.69	1027.61	-739.14	1451.71	809.81	-270.59	1706.31
3	1274.32	2500.00	1175.90	2550.07	1090.62	2501.10	3508.36	-1034.93	2825.89	3510.22	.01	3194.48
4	696.81	0.00	94.10	2616.90	574.10	970.61	5978.03	-738.15	1457.38	6196.28	-270.84	1709.52
5	2720.35	0.00	2135.04	3000.00	483.26	0.00	5834.45	-418.76	2359.53	5897.72	.02	2592.27
6	3001.43	4000.00	1891.74	0.00	1363.45	4000.00	7000.00	-2333.47	3715.67	7000.00	-1000.00	4000.01

Figure 18 Output from DECEL1.

AD-A093 356 CIVIL ENGINEERING LAB (NAVY) PORT HUENEME CA F/G 13/13
DECEL1 USERS MANUAL. A FORTRAN IV PROGRAM FOR COMPUTING THE STA--ETC(U)
AUG 80 S SERGEV
UNCLASSIFIED CEL-TN-1584 NL

OF 3



MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

ARRAY JUNCTIONS

JUNC. NO.	CABLE AT JUNCTION	TENSION AT JUNCTION	CABLE ANGLES WRT X-AXIS	CABLE ANGLES WRT XY-PLANE	JUNCTION LOCATION X-COORD	JUNCTION LOCATION Y-COORD	JUNCTION LOCATION Z-COORD	DISP FROM NO CURRENT X-DISP	DISP FROM NO CURRENT Y-DISP	DISP FROM NO CURRENT Z-DISP	DISP FROM ORIG NO CURRENT X-DISP	DISP FROM ORIG NO CURRENT Y-DISP	DISP FROM ORIG NO CURRENT Z-DISP
2	1	2704.86	136.81	-60.44	1172.55	-421.42	2354.31	62.33	-421.42	-234.28	62.33	-421.42	-234.28
2	2	696.39	-104.61	-63.07									
2	3	1183.16	-27.14	-1.28									
4	3	1183.48	-152.72	-.50	5834.45	-418.76	2359.53	-63.27	-418.78	-232.74	-63.27	-418.78	-232.74
4	4	696.[illegible]	-75.56	-63.00									
4	5	2720.35	43.31	-60.55									
7	6	3401.43	90.00	-88.23	7000.00	-2333.47	3715.67	.00	-1333.47	-284.34	.00	-1333.47	-284.34

INDEXED DEVICES ALONG ARRAY CABLES

DEVICE INDEX	CABLE NO.	S COORDINATE	TENSION AT DEVICE	DEVICE LOCATION X-COORD	DEVICE LOCATION Y-COORD	DEVICE LOCATION Z-COORD	DISP FROM NO CURRENT X-DISP	DISP FROM NO CURRENT Y-DISP	DISP FROM NO CURRENT Z-DISP	DISP FROM ORIG NO CURRENT X-DISP	DISP FROM ORIG NO CURRENT Y-DISP	DISP FROM ORIG NO CURRENT Z-DISP
1	1	750.00	2256.30	315.98	589.93	542.51	-18.43	-108.85	-56.97	-18.43	-108.85	-56.97
2	1	1500.00	2398.83	614.23	208.61	1115.20	-11.43	-227.84	-123.46	-11.43	-227.84	-123.46
3	1	2250.00	2547.87	898.33	-134.96	1718.08	16.27	-340.47	-186.34	16.27	-340.47	-186.34
4	2	750.00	521.60	1067.69	-688.35	1662.67	185.63	-482.83	-241.75	185.63	-482.83	-241.75
5	2	1500.00	341.51	906.55	-820.23	943.19	280.89	-383.78	-295.48	280.89	-383.78	-295.48
6	2	2250.00	169.94	620.14	-894.13	257.07	285.72	-195.35	-342.41	285.72	-195.35	-342.41
7	3	1000.00	1193.47	2092.39	-802.26	2417.37	-11.28	-802.26	-267.46	-11.28	-802.26	-267.46
8	3	2000.00	1239.35	3040.22	-1006.85	2650.43	-16.97	-1006.86	-330.32	-16.97	-1006.86	-330.32
9	3	2500.00	1274.32	3507.35	-1034.92	2825.47	-1.90	-1034.93	-368.51	-1.90	-1034.93	-368.51
10	3	3000.00	1245.35	3972.33	-1007.15	2683.28	14.13	-1007.16	-337.45	14.13	-1007.16	-337.45
11	3	4000.00	1196.75	4916.46	-801.46	2436.58	10.14	-801.48	-271.24	10.14	-801.48	-271.24
12	4	750.00	522.08	5938.34	-686.98	1668.23	-186.18	-481.25	-239.48	-186.18	-481.25	-239.48
13	4	1500.00	341.95	6098.03	-819.88	948.62	-281.18	-383.08	-292.72	-281.18	-383.08	-292.72
14	4	2250.00	170.11	6381.92	-894.01	261.42	-286.39	-194.93	-339.74	-286.39	-194.93	-339.74
15	5	750.00	2563.14	6107.12	-132.76	1722.43	-17.40	-338.53	-185.29	-17.40	-338.53	-185.29
16	5	1500.00	2413.83	6389.56	210.20	1118.42	10.35	-226.63	-122.92	10.35	-226.63	-122.92
17	5	2250.00	2270.95	6686.00	590.79	544.31	17.69	-108.30	-56.85	17.69	-108.30	-56.85
18	6	1000.00	2149.66	7000.00	-1507.81	861.12	.00	-507.81	-138.88	.00	-507.81	-138.88
19	6	2000.00	2419.27	7000.00	-1930.95	1766.54	.00	-930.95	-233.46	.00	-930.95	-233.46
20	6	3000.00	2704.36	7000.00	-2215.68	2723.92	.00	-1215.68	-276.09	.00	-1215.68	-276.09

ANALYSIS COMPLETED

Figure 18. Continued.

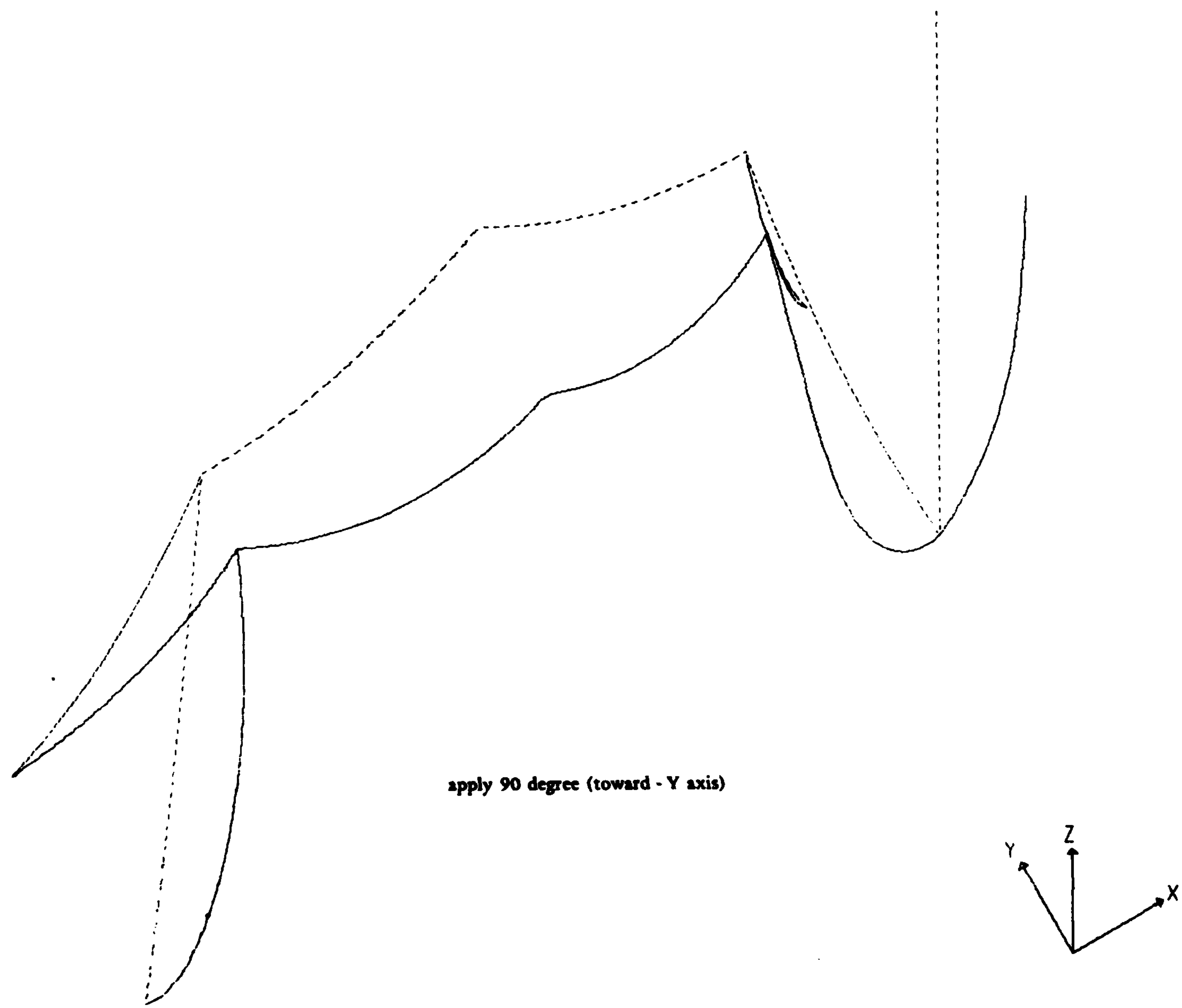


Figure 19. Undeformed and deformed configurations of the test case structure.

Appendix B

DECEL1 PROGRAM LISTING

```
*DECK DECEL1
      PROGRAM DECEL1(INPUT,OUTPUT,TAPE8,TAPE24,TAPE25,TAPE60=INPUT,TAPE6
     1=OUTPUT,TAPE3,TAPE4,TAPE10,NPFILE)
C
C     A FORTRAN IV PROGRAM FOR COMPUTING THE STATIC DEFLECTIONS
C     OF STRUCTURAL CABLE ARRAYS
C
C
C     DECEL1*   IS THE CIVIL ENGINEERING LABORATORY*S ENHANCED
C     VERSION OF THE *DESADE*  PROGRAM WRITTEN BY RICHARD SKOP
C     AND JAMES MARK OF N.R.L.  (*DECEL1*  MEANS DESADE-CEL VERSION1)
C
C
C     QUESTIONS OR COMMENTS ABOUT*DECEL1*SHOULD BE DIRECTED TO-
C     STEVE SERGEV       PHONE-(805) 982-5500
C
C
      COMMON /B3/ VELX(25),VELY(25)
      COMMON /B1/ FEJUNC,IR,DELTAI,DELTA,IRS,TFJUNC,E,ES,FCAB,RCAB,JUMP,
     1PJUNCS,PCAB,PCABE,PCABO,RCABO,THETA,PJUNCO
      COMMON /B2/ NCAB,NNODE,ERJUNC,IRJUNC,DATI,DATN,H,PJUNC,CDCAB,DCAB,
     1FATE,NANC,ANJUNC,IREAD,IPRNT,INTAPE,OUTAPE,ITIME,IFLG,OFLG,NIR,THE
     2TAS,THETAE,COMPD,THETAB,NJUNC,RHO,TEST,NVSEG,ZVEL,VELZ,PIP,ECICAB,
     3EXPCAB,ZJUNC,LJUNC,PATH,ICAB,IVOPT,WCAB,IDEV,ICHECK,NDEV,NDATC
      COMMON /REREF/ NOCUR
      COMMON /TITL/ TITLE(8),PHI,CUNITS,IUNIT,VELXP(25),VELYP(25)
      COMMON /PLTT/ KPPLT,SIZE,TH(3),IPOPT,KCPLT
      COMMON /NITER/ KOUNIP,NIT,MAXITER,NSTEPS,ISTEP,PERCNTV,INCPRNT
      COMMON /PIBLK/ PI
      DIMENSION FEJUNC(3,44), IR(3,44), IRS(3,44), TFJUNC(3,44), PJUNCO(
     13,44)
      DIMENSION FCAB(3,51,22), RCAB(3,51,22), PJUNCS(3,44), PCAB(3,51,22
     1)
      DIMENSION PCABE(3,51,22), PCABO(3,51,22), RCABO(3,51,22)
      DIMENSION NNODE(22), ERJUNC(44), IRJUNC(44), DATI(10), DATN(10), H
     1(22)
      DIMENSION PJUNC(3,44), CDCAB(22), DCAB(22), ANJUNC(44), TEST(14)
      DIMENSION ZVEL(25), VELZ(25), ECICAB(22), EXPCAB(22), ZJUNC(22)
      DIMENSION LJUNC(22), PATH(22), ICAB(22), WCAB(22), IDEV(1000)
      DIMENSION ICHECK(44)
      DIMENSION DATIT(2150,13)
      EQUIVALENCE (DATIT(1),FEJUNC(1))
      INTEGER OUTAPE,ZJUNC,ERJUNC,ANJUNC,OFLG
      INTEGER PATH
      REAL IR,IRS
      CALL INFORM
      PI=2.*ASIN(1.0)
C
C     NIT IS THE NUMBER OF ITERATIONS ALLOWED BEFORE THE PROGRAM IS
C     TERMINATED.
C     IF CONVERGENCE HAS NOT BEEN REACHED BY NIT/2 ITERATIONS, AN
C     AVERAGE OF SUCCESSIVE NODAL POSITIONS WILL BE MADE FOR AN
C     ADDITIONAL NIT/2 ITERATIONS.
C
    5 IFIRST=0
      ISCR=25
      REWIND ISCR
```

```
      KDUMMY=0
      MCUMMY=0
      KCUNTR=0
C
      ITIME=1
C     CALL INPUT TO READ DATA AND IDENTIFY ERRORS
C
   10 CALL INPUT
      IF (NOCUR.NE.0) IFIRST=0
C
C     CHECK TO SEE IF ANY ERRORS IN DATA
C
      IF (FATE.NE.0.) GO TO 305
C
C     GET HERE IF NO ERRORS -- PRINT OUT PHYSICAL CHARACTERISTICS OF ARR
C
      WRITE (IPRNT,310)
      CALL PHSOUT
C
C     KMULT IS A MULTIPLIER FOR CHANGING CURRENT ANGLE THETA
C
      KMULT=0
      IF (IFIRST.NE.0) GO TO 15
C
C     JUMP=0---NO CURRENT   JUMP=1---CURRENT
C
      JUMP=0
   15 IF (IVOPT.EQ.0) GO TO 20
      KCUNTR=0
      THTN=THETAB+KMULT*THETAS
      THETA=360.+PHI-THTN
      IFTHT=0
      IF (NSTEPS.GT.1) ISTEP=1
C
C     GET HERE TO CALCULATE FORCES AND IF SUCCESSIVE APPROXIMATION ROUTI
C     NOT SATISFIED -- ZERO FORCES
C
   20 DO 25 J=1,NJUNC
      DO 25 I=1,3
   25 FEJUNC(I,J)=0.
      DO 30 N=1,NCAB
      INNN=NNODE(N)
      DO 30 M=1,INNN
      DO 30 I=1,3
   30 FCAB(I,M,N)=0.
C
C     PICK UP DISCRETE DEVICE DATA FROM TEMPORARY STORAGE TAPE AND
C     CALCULATE DEVICE FORCES -- DJNC FORCES ARE STORED IN FEJUNC --
C     DCAB FORCES IN FCAB -- EFORCE(I) IS ROUTINE FOR CALCULATING
C     DEVICE FORCES IN DIRECTION I
C
   35 READ (INTAPE,315) (DATI(K),K=1,10)
      IF (DATI(2).EQ.TEST(3)) GO TO 40
      IF (DATI(2).EQ.TEST(4)) GO TO 50
      IF (DATI(2).EQ.TEST(9)) GO TO 60
      GO TO 35
   40 K=DATI(3)
```

```
      DO 45 J=1,3
      I=J
   45 FEJUNC(I,K)=FEJUNC(I,K)+EFORCE(I,MDUMMY,KDUMMY)
      GO TO 35
   50 K=DATI(3)
      M=DATI(1,J)/H(K)+1.000001
      DO 55 J=1,3
      I=J
   55 FCAB(I,M,K)=FCAB(I,M,K)+CFORCE(I,M,K)
      GO TO 35
C
C     GET HERE AT END OF TAPE
C
   60 REWIND INTAPE
C
C     NOW CALCULATE THE FORCE/LENGTH IN DIRECTION I AT NODE M ON CABLE N
C     CFORCE(I,P,N) IS ROUTINE FOR DOING THIS -- INTEGRATE BY TRAPEZOIDA
C     RULE OVER SEGMENT TO GET TOTAL FORCE AND ADD TO DCAB FORCES
C
      DO 65 J=1,NCAB
      K=J
      INNN=NNODE(K)-1
      DO 65 MM=1,INNN
      M=MM
      DO 65 II=1,3
      I=II
   65 FCAB(I,M,K)=FCAB(I,M,K)+(CFORCE(I,M,K)+CFORCE(I,M+1,K))*H(K)*0.5
C
C     ALL FORCES ARE NOW CALCULATED AND EQUILIBRIUM CAN BE DETERMINED
C     LEAP = 1  FIRST TIME THROUGH IMAGINARY REACTION ROUTINE
C     LEAP = 2  ANY OTHER TIME
C     SKIP THIS SECTION IF NO IR#S
C
      IF (NIR.EQ.0) GO TO 70
      IF (JUMP.EQ.0) CALL START
      LEAP=1
C
C     INITIALIZE DELTA
C
      DELTA=DELTAI
C
C     GET HERE TO INITIALIZE TOTAL FORCES AT THE JUNCTIONS, TFJUNC, AND
C     IF THE IMAGINARY REACTION ITERATION NOT SATISFIED -- ALSO IF NO IR
C
   70 DO 75 J=1,NJUNC
      DO 75 I=1,3
   75 TFJUNC(I,J)=FEJUNC(I,J)
C
C     ADD APPROPRIATE REACTIONS TO TFJUNC -- SKIP THIS SECTION IF NO IR#
C
      IF (NIR.EQ.0) GO TO 95
      DO 90 J=1,NJUNC
      DO 90 K=1,NIR
      IF ((J.EQ.IRJUNC(K)).OR.(J.EQ.ERJUNC(K))) GO TO 80
      GO TO 90
   80 DO 85 I=1,3
   85 TFJUNC(I,J)=TFJUNC(I,J)+IR(I,J)
```

```
   90 CONTINUE
C
C     TFJUNC IS NOW DETERMINED AND THE REACTIVE FORCES IN THE ARRAY, RCA
C     CAN BE CALCULATED BY SUMMING FROM THE FREE ENDS TO THE FIXED ANCHO
C
   95 DO 130 N=1,NCAB
      INDEX=NCAB+1-N
      K=PATH(INDEX)
      INNN=NNODE(K)
      INLJ=LJUNC(K)
      DO 100 I=1,3
  100 RCAB(I,INNN,K)=TFJUNC(I,INLJ)
      DO 115 L=1,NCAB
      IF (LJUNC(K).EQ.ZJUNC(L)) GO TO 105
      GO TO 115
  105 DO 110 I=1,3
  110 RCAB(I,INNN,K)=RCAB(I,INNN,K)+RCAB(I,1,L)
  115 CONTINUE
      DO 125 MM=1,INNN
      M=INNN+1-MM
      IF (M.EQ.1) GO TO 130
      DO 120 I=1,3
  120 RCAB(I,M-1,K)=RCAB(I,M,K)+FCAB(I,M-1,K)
  125 CONTINUE
  130 CONTINUE
C
C     ALL REACTIVE FORCES ARE NOW DETERMINED AND THE CONFIGURATION OF TH
C     ARRAY, PCAB AND PJUNC, CAN BE FOUND BY INTEGRATING FROM THE FIXED
C     ANCHOR TO THE FREE ENDS -- INTEGRATION BY THE TRAPEZOIDAL RULE IS
C     AGAIN USED
C
      DO 155 N=1,NCAB
      K=PATH(N)
      INLN=LJUNC(K)
      INNN=NNODE(K)
      INZJ=ZJUNC(K)
      DO 135 I=1,3
  135 PCAB(I,1,K)=PJUNC(I,INZJ)
      DO 145 MM=2,INNN
      M=MM
      DO 145 II=1,3
      I=II
      IF (TCAB(M,K).NE.0.) GO TO 140
      PCAB(I,M,K)=PCAB(I,M-1,K)
      GO TO 145
  140 PCAB(I,M,K)=PCAB(I,M-1,K)+(EXCAB(M-1,K)*RCAB(I,M-1,K)/TCAB(M-1,K)+
     1EXCAB(M,K)*RCAB(I,M,K)/TCAB(M,K))*H(K)/2.
  145 CONTINUE
      DO 150 I=1,3
  150 PJUNC(I,INLN)=PCAB(I,INNN,K)
  155 CONTINUE
      IF (JUMP.EQ.0) GO TO 175
      IF (KOUNTR.LT.NIT/2) GO TO 175
      DO 170 N=1,NCAB
      K=PATH(N)
      INLN=LJUNC(K)
      INNN=NNODE(K)
```

```
      DO 160 M=1,INNN
      DO 160 I=1,3
  160 PCAB(I,M,K)=0.5*(PCAB(I,M,K)+PCABE(I,M,K))
      DO 165 I=1,3
  165 PJUNC(I,INLN)=PCAB(I,INNN,K)
  170 CONTINUE
  175 CONTINUE
C
C     ARRAY CONFIGURATION NOW DETERMINED -- CHECK TO SEE IF IT SATISFIES
C     GEOMETRIC CONSTRAINTS -- SKIP THIS SECTION IF NO IR#S
C
      IF (NIR.EQ.0) GO TO 245
C
C     CALCULATE ERROR E
C
      E2=0.
      DO 180 N=1,NIR
      KEN=ERJUNC(N)
      KIN=IRJUNC(N)
      DO 180 I=1,3
  180 E2=E2+(PJUNC(I,KEN)-PJUNC(I,KIN))**2
      E=SQRT(E2)
C
C     COMPARE ERROR TO ACCURACY REQUIREMENTS
C
      IF (E.LE.COMPD/10.) GO TO 245
C
C     GET HERE IF GEOMETRIC CONSTRAINTS NOT SATISFIED
C
      GO TO (185,220), LEAP
C
C     GET HERE FIRST TIME THROUGH IMAGINARY REACTION ROUTINE
C
  185 LEAP=2
      KNTR=0
      EPREV=0.0
C
C     STORE SUCCESSFUL POSITIONS AND REACTIONS
C
  190 ES=E
      KNTR=KNTR+1
C     ALLOW MXITER/2 ITERATIONS THEN BEGIN THE CHECK FOR SLOW CONVERGENC
      IF (KNTR.LE.MXITER/2) GO TO 210
C     ARBITRARY DEFINITION OF SLOW CONVERGENCE - IF THE DISPLACEMENT
C      ERROR IS LARGE COMPARED TO THE CONVERGENCE TOLERANCE AND IS
C      CHANGING SLOWLY - SLOW CONVERGENCE IS INDICATED AFTER MXITER/2
C      ITERATIONS
      IF (KNTR.GT.1.AND.E.GT.COMPD*100..AND.EPREV-E.LT.COMPD) GO TO 195
C     LIMIT THE ITERATIONS TO SATISFY THE DISPLACEMENT TOLERANCE AT THE
C     CUTS TO MXITER
      IF (KNTR.GT.MXITER) GO TO 200
      GO TO 210
  195 WRITE (IPRNT,320) KNTR
      GO TO 205
  200 WRITE (IPRNT,325) MXITER
  205 WRITE (IPRNT,330) TITLE
      WRITE (IPRNT,335) EPREV,E,COMPD
```

```
      IPCTVEL=PERCNTV*100.
      IF (NSTEPS.GT.1) WRITE (IPRNT,340) IPCTVEL
      WRITE (IPRNT,345)
      GO TO 300
  210 EPREV=E
      DO 215 N=1,NIR
      KEN=ERJUNC(N)
      KIN=IRJUNC(N)
      DO 215 I=1,3
      PJUNCS(I,KEN)=PJUNC(I,KEN)
      PJUNCS(I,KIN)=PJUNC(I,KIN)
  215 IRS(I,KIN)=IR(I,KIN)
      GO TO 225
C
C     GET HERE ANY OTHER TIME THROUGH IMAGINARY REACTION ROUTINE
C     SEE IF ITERATION SUCCESSFUL
C
  220 IF (E.LT.ES) GO TO 190
C
C     REDUCE DELTA IF NOT SUCCESSFUL INTERATION
C
      DELTA=DELTA/2.
C
C     CALCULATE NEW IMAGINARY AND EQUILIBRATING REACTIONS AND GO BACK TO
C     RECALCULATE ARRAY EQUILIBRIUM
C
  225 DO 230 N=1,NIR
      KEN=ERJUNC(N)
      DO 230 I=1,3
  230 IR(I,KEN)=0.
      DO 235 N=1,NIR
      KEN=ERJUNC(N)
      KIN=IRJUNC(N)
      DO 235 I=1,3
      IR(I,KIN)=IRS(I,KIN)+DELTA*(PJUNCS(I,KEN)-PJUNCS(I,KIN))/ES
  235 IR(I,KEN)=IR(I,KEN)-IR(I,KIN)
C
C     CHECK CHANGES IN IMAGINARY REACTIONS
C
      DO 240 N=1,NIR
      KIN=IRJUNC(N)
      DO 240 I=1,3
      IF (IR(I,KIN).NE.IRS(I,KIN)) GO TO 70
  240 CONTINUE
C
C     NO CHANGES -- TIME TO QUIT
C
      CALL ERROR
      GO TO 305
C
C     GET HERE IF ACCURACY REQUIREMENTS SATISFIED OR NO IR*S
C     OUTPUT EQUILIBRIUM IF NO CURRENT -- IF CURRENT, FIRST CHECK TO SEE
C     IF ACCURACY REQUIREMENT SATISFIED BY SUCCESSIVE APPROXIMATIONS
C
  245 CONTINUE
      IF (JUMP.NE.0) GO TO 250
  250 CONTINUE
```

```
      JUM=JUMP+1
      GO TO (255,235), JUM
  255 IF ((OFLG.EQ.0).OR.(OFLG.EQ.2)) CALL STROUT
      IF (KPPLT.NE.0.AND.JUM.NE.1) CALL PERPLT (IVOPT,NCAB,NNODE,PCAB,PC
     1ABO,TITLE)
      IF ((OFLG.EQ.1).OR.(OFLG.EQ.2)) CALL TAPOUT
      IF (OFLG.EQ.1) GO TO 270
      IF (JUM.NE.1) GO TO 270
      DO 260 N=1,NCAB
      INNN=NNODE(N)
      DO 260 M=1,INNN
      DO 260 I=1,3
      PCABO(I,M,N)=PCAB(I,M,N)
  260 RCABO(I,M,N)=RCAB(I,M,N)
      DO 265 N=1,NJUNC
      DO 265 I=1,3
  265 PJUNCO(I,N)=PJUNC(I,N)
      IF (KPPLT.NE.0.AND.IVOPT.EQ.0) CALL PERPLT (IVOPT,NCAB,NNODE,PCAB,
     1PCABO,TITLE)
C
C     APPLY CURRENT IF REQUIRED
C
  270 IF (IVOPT.EQ.0) GO TO 300
      JUMP=1
      IF (JUM.EQ.1) GO TO 275
      IF (KCPLT.NE.0) CALL CPLT (IVOPT,IPRNT,PJUNC,NANC,TITLE,ANJUNC)
      IF (THTN.GE.THETAE) GO TO 300
      KMULT=KMULT+1
      IFTHT=1
C
C     STORE EXISTING CONFIGURATION FOR COMPARISON PURPOSES
C
  275 DO 280 N=1,NCAB
      INNN=NNODE(N)
      DO 280 M=1,INNN
      DO 280 I=1,3
      PCABE(I,M,N)=PCAB(I,M,N)
  280 CONTINUE
C
C     RECALCULATE FORCES
C
      IF (IFTHT.EQ.0) GO TO 20
      GO TO 15
C
C     GET HERE IF CURRENT -- CHECK SUCCESSIVE APPROXIMATION ACCURACY
C
  285 KOUNTR=KOUNTR+1
      RACCY=SQRT(U)
C     LIMIT THE TOTAL NUMBER OF ITERATIONS TO GET THE CABLE SHAPE
C      TO NIT ITERATIONS
      IF (KOUNTR.GE.NIT) WRITE (IPRNT,350) KOUNTR,RACCY,COMPD
      IF (KOUNTR.GE.NIT) CALL STROUT
      IF (KOUNTR.GE.NIT) GO TO 300
      DO 295 N=1,NCAB
      INNN=NNODE(N)
      DO 295 M=1,INNN
      U=0.
```

```
            DO 290 I=1,3
        290 U=U+(PCABE(I,M,N)-PCAB(I,M,N))**2
      C
      C     IF NOT ACCURATE STORE CONFIGURATION AND RECALCULATE FORCES
      C
            IF (SQRT(U).GT.COMPD) GO TO 275
        295 CONTINUE
      C
      C     GET HERE IF POSITION ACCURATE AND OUTPUT POSITION
      C
            IF (INCPRNT.EQ.1.AND.ISTEP.LT.NSTEPS) CALL STROUT
      C     CHECK TO SEE IF CURRENT IS TO BE INCREMENTED
            IF (NSTEPS.EQ.1) GO TO 255
            IF (ISTEP.LE.NSTEPS) ISTEP=ISTEP+1
            IF (ISTEP.GT.NSTEPS) GO TO 255
            GO TO 275
      C
      C     GO BACK FOR MORE DATA
      C
        300 IFIRST=1
            NOUNTH=0
            GO TO 10
        305 CONTINUE
            WRITE (IPRNT,355)
            GO TO 5
      C
        310 FORMAT (///,5X,18HNO ERRORS DETECTED)
        315 FORMAT (F4.0,A4,8E15.8)
        320 FORMAT (1H1,23HSLOW CONVERGENCE AFTER ,I5,11H ITERATIONS/)
        325 FORMAT (1H1,18HNO CONVERGENCE IN ,I5,11H ITERATIONS/)
        330 FORMAT (11H CASE TITLE/1X,10(1H=)/1X,8A10/)
        335 FORMAT (24H PREVIOUS ERROR VALUE = ,E15.5/24H  PRESENT ERROR VALUE
           1 = ,E15.5/33H ACCEPTABLE ERROR (COMP VALUE) = ,E15.5)
        340 FORMAT (/29H PRESENT VALUE OF CURRENT = ,I4,22H PERCENT OF FULL VA
           1LUE)
        345 FORMAT (//39H PARAMETRIC CASE TERMINATED, SEE MANUAL)
        350 FORMAT (/1X,30HPROGRAM DID NOT CONVERGE AFTER,I5,1X,38HITERATIONS,
           1 PARAMETRIC CASE TERMINATED//26H BEST ACCURACY OBTAINED = ,E15.4/2
           27H DESIRED ACCURACY (COMP) = ,E15.4///28H APPROXIMATE RESULTS PRIN
           3TED/1X,27(1H=))
        355 FORMAT (1H1)
            END
```

CARD NR.	SEVERITY	DETAILS	DIAGNOSIS OF PROBLEM
258	I		AN IF STATEMENT MAY BE MORE EFFICIENT THAN A 2 OR 3 BRANCH COMPUTED GO TO STATEMENT.
341	I	250	THIS IF DEGENERATES INTO A SIMPLE TRANSFER TO THE LABEL INDICATED.
344	I		AN IF STATEMENT MAY BE MORE EFFICIENT THAN A 2 OR 3 BRANCH COMPUTED GO TO STATEMENT.

```
*DECK INFORM                                                            INF   1
      SUBROUTINE INFORM                                                 INF   2
C     ==================================================================INF   3
C                                                                       INF   4
C     THIS SUBROUTINE IS USED TO INFORM THE USER OF UPDATES THAT HAVE   INF   5
C      BEEN ADDED TO DECEL1 THAT MAY AFFECT INPUT OR CALCULATIONS OR    INF   6
C      OUTPUT.                                                          INF   7
C     ANY NEW UPDATES SHOULD BE DESCRIBED HERE BY ADDING TO THE         INF   8
C      INFORMATIVE PRINT STATEMENTS                                     INF   9
C                                                                       INF  10
C     ==================================================================INF  11
      PRINT 5                                                           INF  12
      PRINT 10                                                          INF  13
      RETURN                                                            INF  14
C                                                                       INF  15
    5 FORMAT (1H1,26H DECEL1 UPDATE INFORMATION/2X,25(1H=)/)            INF  16
   10 FORMAT (76H THIS IS THE JANUARY 1980 VERSION OF DECEL1 AS DESCRIBEINF  17
     1D IN THE USERS MANUAL/26H  NO UPDATES HAVE BEEN ADDED)            INF  18
      END                                                               INF  19-
```

```
*DECK CFORCE
      FUNCTION CFORCE (I,M,N)
C
C     THIS ROUTINE CALCULATES THE FORCE/LENGTH IN DIRECTION I AT NODE M
C     ON CABLE N USING THE NORMAL DRAG FORCE APPROXIMATION
C
      COMMON /B3/ VELX(25),VELY(25)
      COMMON /B1/ FEJUNC,IR,DELTAI,DELTA,IRS,TFJUNC,E,ES,FCAB,RCAB,JUMP,
     1PJUNCS,PCAB,PCABE,PCABO,RCABO,THETA,PJUNCO
      COMMON /B2/ NCAB,NNODE,ERJUNC,IRJUNC,DATI,DATN,F,PJUNC,CDCAB,DCAB,
     1FATE,NANC,ANJUNC,IREAD,IPRNT,INTAPE,OUTAPE,ITIME,IFLG,OFLG,NIR,THEC
     2TAS,THETAE,COMPD,THETAB,NJUNC,RHO,TEST,NVSEG,ZVEL,VELZ,PIP,ECICAB,
     3EXPCAB,ZJUNC,LJUNC,PATH,ICAB,IVOPT,WCAB,IDEV,ICHECK,NDEV,NDATC
      COMMON /TANDHG/ TDCAB(22),TDDCAB(1000)
      COMMON /PIBLK/ PI
      DIMENSION FEJUNC(3,44), IR(3,44), IRS(3,44), TFJUNC(3,44), PJUNCO(
     13,44)
      DIMENSION FCAB(3,51,22), RCAB(3,51,22), PJUNCS(3,44), PCAB(3,51,22
     1)
      DIMENSION PCABE(3,51,22), PCABO(3,51,22), RCABO(3,51,22)
      DIMENSION NNODE(22), ERJUNC(44), IRJUNC(44), DATI(10), DATN(10), H
     1(22)
      DIMENSION PJUNC(3,44), CDCAB(22), DCAB(22), ANJUNC(44), TEST(14)
      DIMENSION ZVEL(25), VELZ(25), ECICAB(22), EXPCAB(22), ZJUNC(22)
      DIMENSION LJUNC(22), PATH(22), ICAB(22), WCAB(22), IDEV(1000)
      DIMENSION ICHECK(44)
      DIMENSION WTCAB(3), VNORM(3), PSPACE(3)
      DIMENSION WW(3), VT(3)
      INTEGER OUTAPE,ZJUNC,ERJUNC,ANJUNC,OFLG
      INTEGER PATH
      REAL IR,IRS
C
C     CALCULATE THE WEIGHT/LENGTH VECTOR
C
      WTCAB(1)=0.
      WTCAB(2)=0.
      WTCAB(3)=WCAB(N)
C
C     CHECK TO SEE IF CURRENT OR NO CURRENT
C
      JUM=JUMP+1
      GO TO (5,10), JUM
C
C     GET HERE IF NO CURRENT
C
    5 CFORCE=WTCAB(I)
      RETURN
C
C     GET HERE IF CURRENT
C     CALCULATE LOCATION OF NODE IN SPACE
C
   10 DO 15 K=1,3
   15 PSPACE(K)=PCAB(K,M,N)
      IF (IVOPT.EQ.3) CALL INTVEL (WW,PSPACE)
      IF (IVOPT.EQ.3) GO TO 25
      DO 20 K=1,3
   20 WW(K)=VELOC(K,PSPACE)
```

```
   25 CONTINUE                                                          CFO  58
C                                                                       CFO  59
C     CALCULATE THE TANGENTIAL PROJECTION OF THE CURRENT ON THE CABLE   CFO  60
C                                                                       CFO  61
      VPROJ=0.                                                          CFO  62
      DO 30 KK=1,3                                                      CFO  63
      K=KK                                                              CFO  64
   30 VPROJ=VPROJ+WW(K)*RCAB(K,M,N)/TCAB(M,N)                           CFO  65
C                                                                       CFO  66
C     CALCULATE THE NORMAL COMPONENT OF THE CURRENT AND ITS MAGNITUDE   CFO  67
C                                                                       CFO  68
      DO 35 KK=1,3                                                      CFO  69
      K=KK                                                              CFO  70
   35 VNORM(K)=WW(K)-VPROJ*RCAB(K,M,N)/TCAB(M,N)                        CFO  71
      VNMAG=SQRT(VNORM(1)**2+VNORM(2)**2+VNORM(3)**2)                   CFO  72
C                                                                       CFO  73
C     CALCULATE THE FORCE/LENGTH                                        CFO  74
C                                                                       CFO  75
C                                                                       CFO  76
C     CALCULATE TANGENTIAL COMPONENT OF CURRENT AND ITS MAGNITUDE       CFO  77
C                                                                       CFO  78
      VT(1)=WW(1)-VNORM(1)                                              CFO  79
      VT(2)=WW(2)-VNORM(2)                                              CFO  80
      VT(3)=WW(3)-VNORM(3)                                              CFO  81
      VTM=SQRT(VT(1)**2+VT(2)**2+VT(3)**2)                              CFO  82
      CFORCE=W(CAB(1)+RHO*.5*(DCAB(N)/12.)*EXCAB(M,N)*(VNMAG*VNORM(I)*CDCFO  83
     1CAB(N)+VTM*VT(1)*TDCAB(N)*PI)                                     CFO  84
      RETURN                                                            CFO  85
      END                                                               CFO  86
```

CARD NR. SEVERITY DETAILS   DIAGNOSIS OF PROBLEM

42   I   AN IF STATEMENT MAY BE MORE EFFICIENT THAN A 2 OR 3 BRANCH COMPUTED GO TO STATEMENT.

```
*DECK EFORCE
      FUNCTION EFORCE (I,M,N)
C
C     THIS ROUTINE CALCULATES THE DEVICE FORCES IN DIRECTION I
C     USING THE NORMAL DRAG APPROXIMATION FOR IN-LINE DEVICES
C
      COMMON /B3/ VELX(25),VELY(25)
      COMMON /B1/ FEJUNC,IR,DELTAI,DELTA,IRS,TFJUNC,E,ES,FCAB,RCAB,JUMP,
     1PJUNCS,PCAB,PCABE,PCABO,RCABO,THETA,PJUNCO
      COMMON /B2/ NCAB,NNODE,ERJUNC,IRJUNC,DATI,DATN,F,PJUNC,CDCAB,DCAB,
     1FATE,NANC,ANJUNC,IHEAD,IPRNT,INTAPE,OUTAPE,ITIME,IFLG,OFLG,NIR,THE
     2IAS,THETAE,CUPPD,THETAB,NJUNC,RHO,TEST,NVSEG,ZVEL,VELZ,PIP,ECICAB,
     3EXPCAB,ZJUNC,LJUNC,PATH,ICAB,IVOPT,WCAB,IDEV,ICHECK,NDEV,NDATC
      COMMON /TANDRG/ TDCAB(22),TDDCAB(1000)
      COMMON /PIBLK/ PI
      DIMENSION FEJUNC(3,44), IR(3,44), IRS(3,44), TFJUNC(3,44), PJUNCO(
     13,44)
      DIMENSION FCAB(3,51,22), RCAB(3,51,22), PJUNCS(3,44), PCAB(3,51,22
     1)
      DIMENSION PCABE(3,51,22), PCABO(3,51,22), RCABO(3,51,22)
      DIMENSION NNODE(22), ERJUNC(44), IRJUNC(44), DATI(10), DATN(10), F
     1(22)
      DIMENSION PJUNC(3,44), CDCAB(22), DCAB(22), ANJUNC(44), TEST(14)
      DIMENSION ZVEL(25), VELZ(25), ECICAB(22), EXPCAB(22), ZJUNC(22)
      DIMENSION LJUNC(22), PATH(22), ICAB(22), WCAB(22), IDEV(1000)
      DIMENSION ICHECK(44)
      DIMENSION WTEL(3), VNORM(3), PSPACE(3)
      DIMENSION WW(3), WTCAB(3), VT(3)
      INTEGER OUTAPE,ZJUNC,ERJUNC,ANJUNC,OFLG
      INTEGER PATH
      REAL IR,IRS
C
C     INITIALIZE LOCAL VARIABLES
C
      WTCAB(1)=0.
      WTCAB(2)=0.
      WTCAB(3)=WCAB(N)
      DD=DATI(8)
      IF (DATI(4).EQ.1) DD=DATI(8)/12.
      DL=DATI(5)
      DND=DATI(7)
C
C     CALCULATE THE WEIGHT VECTOR OF A DEVICE
C
      WTEL(1)=0.
      WTEL(2)=0.
      WTEL(3)=DATI(6)-DL*WTCAB(3)
C
C     CHECK TO SEE IF CURRENT OR NO CURRENT
C
      JUM=JUMP+1
      GO TO (5,10), JUM
C
C     GET HERE IF NO CURRENT
C
    5 EFORCE=WTEL(I)
      RETURN
```

```
C                                                                       EFO  58
C     GET HERE IF CURRENT                                               EFO  59
C     CALCULATE LOCATION OF DEVICE IN SPACE                             EFO  60
C                                                                       EFO  61
   10 DO 15 KK=1,3                                                      EFO  62
      K=KK                                                              EFO  63
   15 PSPACE(K)=SPACE(K)                                                EFO  64
      IF (IVOPT.EQ.3) CALL INTVEL (WW,PSPACE)                           EFO  65
      IF (IVOPT.EQ.3) GO TO 25                                          EFO  66
      DO 20 K=1,3                                                       EFO  67
   20 WW(K)=VELOC(K,PSPACE)                                             EFO  68
   25 CONTINUE                                                          EFO  69
C                                                                       EFO  70
C     CHECK IF DEVICE IS IN-LINE OR FREE                                EFO  71
C                                                                       EFO  72
      IJMP=DATI(4)                                                      EFO  73
      GO TO (35,30), IJMP                                               EFO  74
C                                                                       EFO  75
C     GET HERE IF FREE TYPE DEVICE -- CALCULATE MAGNITUDE OF THE CURRENTEFO  76
C                                                                       EFO  77
   30 VMAG=SQRT(WW(1)**2+WW(2)**2+WW(3)**2)                             EFO  78
C                                                                       EFO  79
C     CALCULATE THE FORCE ON THE FREE DEVICE                            EFO  80
C                                                                       EFO  81
      EFORCE=WTEL(I)+(RHO/2.)*DATI(7)*DATI(8)*VMAG*WW(I)                EFO  82
      RETURN                                                            EFO  83
C                                                                       EFO  84
C     GET HERE IF IN-LINE DEVICE                                        EFO  85
C     CALCULATE THE TANGENTIAL PROJECTION OF THE CURRENT ON THE DEVICE  EFO  86
C     TANG(I) EVALUATES THE UNIT TANGENT TO A CABLE AT ANY POINT        EFO  87
C                                                                       EFO  88
   35 VPROJ=0.                                                          EFO  89
      DO 40 KK=1,3                                                      EFO  90
      K=KK                                                              EFO  91
   40 VPROJ=VPROJ+WW(K)*TANG(K)                                         EFO  92
C                                                                       EFO  93
C     CALCULATE THE NORMAL COMPONENT OF THE CURRENT AND ITS MAGNITUDE   EFO  94
C                                                                       EFO  95
      DO 45 KK=1,3                                                      EFO  96
      K=KK                                                              EFO  97
   45 VNORM(K)=WW(K)-VPROJ*TANG(K)                                      EFO  98
      VNMAG=SQRT(VNORM(1)**2+VNORM(2)**2+VNORM(3)**2)                   EFO  99
C                                                                       EFO 100
C     CALCULATE THE TANG. COMPONENT OF THE CURRENT AND ITS MAGNITUDE    EFO 101
C                                                                       EFO 102
      VT(1)=WW(1)-VNORM(1)                                              EFO 103
      VT(2)=WW(2)-VNORM(2)                                              EFO 104
      VT(3)=WW(3)-VNORM(3)                                              EFO 105
      VTM=SQRT(VT(1)**2+VT(2)**2+VT(3)**2)                              EFO 106
C                                                                       EFO 107
C     CALCULATE THE FORCE ON THE IN-LINE DEVICE                         EFO 108
C                                                                       EFO 109
      TERM1=WTEL(I)                                                     EFO 110
      TERM2=VNMAG*VNORM(I)*(DL*UND-CDCAB(N)*DCAB(N)/12.)                EFO 111
      TERM3=VTM*VT(I)*PI*(DD*TDCAB(N)-TDCAB(N)*DCAB(N)/12.)             EFO 112
      EFORCE=TERM1+0.5*RHO*DL*(TERM2+TERM3)                             EFO 113
      RETURN                                                            EFO 114
```

```
   115              END                                          EFO 115-

CARD NR. SEVERITY  DETAILS   DIAGNOSIS OF PROBLEM

     52     I                 AN IF STATEMENT MAY BE MORE EFFICIENT THAN A 2 OR 3 BRANCH COMPUTED GO TO STATEMENT.
     74     I                 AN IF STATEMENT MAY BE MORE EFFICIENT THAN A 2 OR 3 BRANCH COMPUTED GO TO STATEMENT.
```

```
      *DECK ERROR                                                       ERR   1
            SUBROUTINE ERROR                                            ERR   2
      C                                                                 ERR   3
      C     THIS ROUTINE GENERATES A TYPE 18 ERROR MESSAGE              ERR   4
      C     GET HERE IF ALL IMAGINARY REACTIONS DO NOT CHANGE           ERR   5
      C                                                                 ERR   6
            COMMON /B3/ VELX(25),VELY(25)                               ERR   7
            COMMON /B1/ FEJUNC,IR,DELTAT,DELTA,IRS,TFJUNC,E,ES,FCAB,RCAB,JUMP,ERR   8
           1PJUNCS,PCAB,PCABE,PCABO,RCABO,THETA,PJUNCO                  ERR   9
            COMMON /B2/ NCAB,NNODE,ERJUNC,IRJUNC,DATI,DATN,H,PJUNC,CDCAB,DCAB,ERR  10
           1FATE,NANC,ANJUNC,IREAD,IPRNT,INTAPE,OUTAPE,ITIME,IFLG,OFLG,NIR,THEERR  11
           2TAS,THETAE,COMPD,THETAB,NJUNC,RHO,TEST,NVSEG,ZVEL,VELZ,PIP,ECICAB,ERR  12
           3EXPCAB,ZJUNC,LJUNC,PATH,ICAB,IVOPT,WCAB,IDEV,ICHECK,NDEV,NDATC  ERR  13
            DIMENSION FEJUNC(3,44), IR(3,44), IRS(3,44), TFJUNC(3,44), PJUNCO(ERR  14
           13,44)                                                       ERR  15
            DIMENSION FCAB(3,51,22), RCAB(3,51,22), PJUNCS(3,44), PCAB(3,51,22ERR  16
           1)                                                           ERR  17
            DIMENSION PCABE(3,51,22), PCABO(3,51,22), RCABO(3,51,22)    ERR  18
            DIMENSION NNODE(22), ERJUNC(44), IRJUNC(44), DATI(10), DATN(10), HERR  19
           1(22)                                                        ERR  20
            DIMENSION PJUNC(3,44), CDCAB(22), DCAB(22), ANJUNC(44), TEST(14) ERR  21
            DIMENSION ZVEL(25), VELZ(25), ECICAB(22), EXPCAB(22), ZJUNC(22)  ERR  22
            DIMENSION LJUNC(22), PATH(22), ICAB(22), WCAB(22), IDEV(1000)   ERR  23
            DIMENSION ICHECK(44)                                        ERR  24
            INTEGER OUTAPE,ZJUNC,ERJUNC,ANJUNC,OFLG                     ERR  25
            INTEGER PATH                                                ERR  26
            REAL IR,IRS                                                 ERR  27
            F=F*10.                                                     ERR  28
            WRITE (IPRNT,25)                                            ERR  29
            JUM=JUMP+1                                                  ERR  30
            GO TO (5,10), JUM                                           ERR  31
          5 WRITE (IPRNT,30)                                            ERR  32
            GO TO 15                                                    ERR  33
         10 WRITE (IPRNT,35) THETA                                      ERR  34
         15 WRITE (IPRNT,40) E                                          ERR  35
            DO 20 N=1,NCAB                                              ERR  36
            NN=N                                                        ERR  37
            WRITE (IPRNT,45) NN                                         ERR  38
            L=NNODE(N)                                                  ERR  39
            DO 20 M=1,L                                                 ERR  40
            MM=M                                                        ERR  41
            T=TCAB(MM,NN)                                               ERR  42
            S=H(NN)*(MM-1.)                                             ERR  43
         20 WRITE (IPRNT,50) T,S                                        ERR  44
            RETURN                                                      ERR  45
      C                                                                 ERR  46
         25 FORMAT (1H1,52H  TYPE 18 ERROR.  STRUCTURAL ANALYSIS NOT COMPLETEDERR  47
           1,/60H  PRINTOUT GIVEN FOR DIAGNOSTIC PURPOSES.  SEE USERS MANUAL./ERR  48
           2)                                                           ERR  49
         30 FORMAT (5X,40HEXISTING CURRENT CONDITION IS NO CURRENT/)    ERR  50
         35 FORMAT (5X,38HEXISTING CURRENT CONDITION IS THETA = ,F3.0/) ERR  51
         40 FORMAT (5X,35HBEST VALUE OF ACCURACY OBTAINED IS ,F6.2)     ERR  52
         45 FORMAT (//5X,29HTHE TENSIONS IN CABLE NUMBER ,I2,4H ARE,/)  ERR  53
         50 FORMAT (7X,2HT=,F10.2,6H AT S=,F10.2)                       ERR  54
            END                                                         ERR  55-
```

CARD NR.	SEVERITY	DETAILS	DIAGNOSIS OF PROBLEM
31	I		AN IF STATEMENT MAY BE MORE EFFICIENT THAN A 2 OR 3 BRANCH COMPUTED GO TO STATEMENT.

```
      *DECK EXCAB
            FUNCTION EXCAB (M,K)
      C
      C     THIS ROUTINE CALCULATES (1 + STRAIN) AT NODE M OF CABLE K
      C
            COMMON /B3/ VELX(25),VELY(25)
            COMMON /B1/ FEJUNC,IR,DELTAI,DELTA,IRS,TFJUNC,E,ES,FCAB,RCAB,JUMP,
           1PJUNCS,PCAB,PCABE,FCABO,RCABO,THETA,PJUNCO
            COMMON /B2/ NCAB,NNODE,ERJUNC,IRJUNC,DATI,DATN,H,PJUNC,COCAB,DCAB,
           1FATE,NANC,ANJUNC,IREAD,IPRNT,INTAPE,OUTAPE,ITIME,IFLG,OFLG,NIR,THE
           2TAS,THETAL,COMPD,THETAB,NJUNC,RHO,TEST,NVSEG,ZVEL,VELZ,PIP,ECICAB,
           3EXPCAB,ZJUNC,LJUNC,PATH,ICAB,IVOPT,WCAB,IDEV,ICHECK,NDEV,NDATC
            DIMENSION FEJUNC(3,44), IR(3,44), IRS(3,44), TFJUNC(3,44), PJUNCO(
           13,44)
            DIMENSION FCAB(3,51,22), RCAB(3,51,22), PJUNCS(3,44), PCAB(3,51,22
           1)
            DIMENSION PCABE(3,51,22), PCABO(3,51,22), RCABO(3,51,22)
            DIMENSION NNODE(22), ERJUNC(44), IRJUNC(44), DATI(10), DATN(10), H
           1(22)
            DIMENSION PJUNC(3,44), COCAB(22), DCAB(22), ANJUNC(44), TEST(14)
            DIMENSION ZVEL(25), VELZ(25), ECICAB(22), EXPCAB(22), ZJUNC(22)
            DIMENSION LJUNC(22), PATH(22), ICAB(22), WCAB(22), IDEV(1000)
            DIMENSION ICHECK(44)
            INTEGER OUTAPE,ZJUNC,ERJUNC,ANJUNC,OFLG
            INTEGER PATH
            REAL IR,IRS
            IF (EXPCAB(K).EQ.0.) GO TO 5
            EXCAB=1.+(TCAB(M,K)/ECICAB(K))**EXPCAB(K)
            RETURN
          5 EXCAB=1.
            RETURN
            END
```

```
*DECK INPUT
      SUBROUTINE INPUT
C
C     THIS ROUTINE READS ALL DATA AND IDENTIFIES ERRORS IN
C     DATI, DECK STRUCTURE, AND ARRAY REPRESENTATION
C
      COMMON /B3/ VELX(25),VELY(25)
      COMMON /B1/ FEJUNC,IR,DELTAI,DELTA,IRS,TFJUNC,E,ES,FCAB,RCAB,JUMP,
     1PJUNCS,PCAB,PCABE,PCABO,RCABO,THETA,PJUNCO
      COMMON /B2/ NCAB,NNODE,ERJUNC,IRJUNC,DATI,DATN,H,PJUNC,CDCAB,DCAB,
     1FATE,NANC,ANJUNC,IREAD,IPRNT,INTAPE,OUTAPE,ITIME,IFLG,OFLG,NIR,THE
     2TAS,THETAE,COMPD,THETAH,NJUNC,RHO,TEST,NVSEG,ZVEL,VELZ,PIP,ECICAB,
     3EXPCAB,ZJUNC,LJUNC,PATH,ICAB,IVOPT,WCAB,IDEV,ICHECK,NDEV,NDATC
      COMMON /CVEL/ VMAG(25,4),VDIR(25,4),ZPT(25,4),XPT(4),YPT(4),NPPS(4
     1),NSTA
      COMMON /IVEL/ IFVEL
      COMMON /REREF/ NUCUR
      COMMON /TANDRG/ TDCAB(22),TDDCAB(1000)
      COMMON /TITL/ TITLE(8),PHI,CUNITS,IUNIT,VELXP(25),VELYP(25)
      COMMON /PL/ IPUNCH,IPNCH,TITLEM(8),DEVWT
      COMMON /BIN/ ISCH
      COMMON /PLTT/ KPPLT,SIZE,TH(3),IPOPT,KCPLT
      COMMON /CPT/ ZUP,ZUN,DZ,XMIN,XMAX,YMIN,YMAX,YIN,ANG,NY
      COMMON /PIBLK/ PI
      COMMON /KITER/ KOUNTR,NIT,MXITER,NSTEPS,ISTEP,PERCNTV,INCPRNT
      DIMENSION FEJUNC(3,44), IR(3,44), IRS(3,44), TFJUNC(3,44), PJUNCO(
     13,44)
      DIMENSION FCAB(3,51,22), RCAB(3,51,22), PJUNCS(3,44), PCAB(3,51,22
     1)
      DIMENSION PCABE(3,51,22), PCABO(3,51,22), RCABO(3,51,22)
      DIMENSION NNODE(22), ERJUNC(44), IRJUNC(44), DATI(10), DATN(10), H
     1(22)
      DIMENSION PJUNC(3,44), CDCAB(22), DCAB(22), ANJUNC(44), TEST(14)
      DIMENSION ZVEL(25), VELZ(25), ECICAB(22), EXPCAB(22), ZJUNC(22)
      DIMENSION LJUNC(22), PATH(22), ICAB(22), WCAB(22), IDEV(1000)
      DIMENSION ICHECK(44)
      DIMENSION DATIT(2130,10)
      DIMENSION ITEST(14)
      DIMENSION STORE(8)
      EQUIVALENCE (DATIT(1),FEJUNC(1))
      EQUIVALENCE (ITEST(1),TEST(1))
      INTEGER OUTAPE,ZJUNC,ERJUNC,ANJUNC,OFLG
      INTEGER PATH
      REAL IR,IRS
C
C     THIS IS THE BEGINNING OF THE INPUT SECTION
C     INITIALIZE ALL CONSTANTS, FLAGS, ARRAYS, AND COUNTERS
C
      IF (ITIME.NE.1) GO TO 20
      ITEST(1)=4H  IR
      ITEST(2)=4H ANC
      ITEST(3)=4HDJNC
      ITEST(4)=4HDCAB
      ITEST(5)=4H CAB
      ITEST(6)=4H DEN
      ITEST(7)=4HCOMP
      ITEST(8)=4H ANG
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      ITEST(9)=4H EOD                                                   INP  58
      ITEST(10)=4HNJNC                                                  INP  59
      ITEST(11)=4H VEL                                                  INP  60
      ITEST(12)=4HNCAT                                                  INP  61
      ITEST(13)=4H LUN                                                  INP  62
      ITEST(14)=4H EOP                                                  INP  63
      PIP=PI/180.                                                       INP  64
      INTAPE=24                                                         INP  65
      ISCR=25                                                           INP  66
      IREAD=60                                                          INP  67
      IPRNT=61                                                          INP  68
      IFEOD=0                                                           INP  69
      INDEV=0                                                           INP  70
      NDATC=0                                                           INP  71
      KFLG=0                                                            INP  72
      NCJUNC=0                                                          INP  73
      KCUP=0                                                            INP  74
      DO 5 I=1,1000                                                     INP  75
    5 IDDCAB(I)=0.                                                      INP  76
      DO 10 I=1,44                                                      INP  77
   10 ICHECK(I)=0                                                       INP  78
      DO 15 I=1,22                                                      INP  79
   15 ICAB(I)=0                                                         INP  80
      NANC=0                                                            INP  81
      IFRHO=0                                                           INP  82
      IFJNC=0                                                           INP  83
      NIR=0                                                             INP  84
      IROW=1                                                            INP  85
      IPNCH=8                                                           INP  86
      KPLT=0                                                            INP  87
   20 FATE=0.                                                           INP  88
      KCPLT=0                                                           INP  89
      KPPLT=0                                                           INP  90
C                                                                       INP  91
C     CHECK LOGICAL UNITS                                               INP  92
C                                                                       INP  93
      IF (ITIME.GT.1) GO TO 50                                          INP  94
      ITIME=2                                                           INP  95
C                                                                       INP  96
C     IF READING  FROM TAPE LUN MUST BE INCLUDED AS A CARD              INP  97
C                                                                       INP  98
      READ (IREAD,620) TITLEM                                           INP  99
C                                                                       INP 100
C     SAVE INPUT ON TAPE                                                INP 101
C                                                                       INP 102
      IBAD=0                                                            INP 103
      IFORM=1                                                           INP 104
      WRITE (ISCR) IFORM,IBAD                                           INP 105
      WRITE (ISCR,620) TITLEM                                           INP 106
      IF (EOF(IREAD)) 25,30                                             INP 107
   25 STOP                                                              INP 108
   30 DECODE (8,625,TITLEM) TST1,TST2                                   INP 109
C                                                                       INP 110
C     CHECK IF FIRST CARD IS LUN OR MAIN TITLE CARD                     INP 111
C                                                                       INP 112
      IF (TST2.EQ.3HLUN) GO TO 35                                       INP 113
C                                                                       INP 114
```

```
      C     FIRST CARD IS TITLE CARD SET DEFAULTS FOR LUN CARD                 INP 115
      C                                                                        INP 116
            DATI(1)=4H                                                         INP 117
            DATI(2)=4H LUN                                                     INP 118
            DATI(3)=60                                                         INP 119
            DATI(4)=61                                                         INP 120
            DATI(5)=24                                                         INP 121
            DATI(6)=0.                                                         INP 122
            DATI(7)=0.                                                         INP 123
            DATI(8)=0.                                                         INP 124
            DATI(9)=0.                                                         INP 125
            DATI(10)=0.                                                        INP 126
            GC TO 40                                                           INP 127
      C                                                                        INP 128
      C     FIRST CARD IS LUN CARD                                             INP 129
      C                                                                        INP 130
         35 DECODE (80,630,TITLEM) DATI                                        INP 131
            IREAD=DATI(3)                                                      INP 132
            IF (DATI(6).NE.0.) IREAD=DATI(7)                                   INP 133
            READ (IREAD,620) TITLEM                                            INP 134
      C                                                                        INP 135
      C     SAVE INPUT ON TAPE                                                 INP 136
      C                                                                        INP 137
            IBAD=0                                                             INP 138
            IFORM=1                                                            INP 139
            WRITE (ISCR) IFORM,IBAD                                            INP 140
            WRITE (ISCR,620) TITLEM                                            INP 141
         40 IPRNT=DATI(4)+0.1                                                  INP 142
         45 IF (IFEOD.EQ.0) GC TO 320                                          INP 143
            IF (IFEOD.NE.0) GC TO 160                                          INP 144
      C                                                                        INP 145
      C     READ ONE INPUT RECORD INTO DATA ARRAY                              INP 146
      C                                                                        INP 147
         50 CONTINUE                                                           INP 148
            IF (IFLG.EQ.0) READ (IREAD,620) STORE                              INP 149
            IF (IFLG.EQ.1) READ (IREAD,635) (DATI(I),I=1,10),EX,NSEG           INP 150
      C                                                                        INP 151
      C     SAVE INPUT ON TAPE                                                 INP 152
      C                                                                        INP 153
            IBAD=0                                                             INP 154
            IFORM=2                                                            INP 155
            WRITE (ISCR) IFORM,IBAD                                            INP 156
            IF (IFLG.EQ.0) WRITE (ISCR,620) STORE                              INP 157
            IF (IFLG.EQ.0) DECODE (80,630,STORE) DATI,EX,NSEG                  INP 158
      C                                                                        INP 159
      C     TYPE AND BRANCH                                                    INP 160
      C                                                                        INP 161
            IF (IFEOD.EQ.0) GC TO 55                                           INP 162
            IF ((DATI(2).EQ.TEST(12)).OR.(DATI(2).EQ.TEST(14))) GO TO 55       INP 163
            GC TO 615                                                          INP 164
         55 DC 60 I=1,14                                                       INP 165
            IF (DATI(2).EQ.TEST(I)) GO TO (65,85,100,105,120,130,615,615,135,1INP 166
           150,615,155,615,325), I                                             INP 167
         60 CONTINUE                                                           INP 168
      C                                                                        INP 169
      C     GET HERE IF CARD UNIDENTIFIABLE                                    INP 170
      C                                                                        INP 171
```

```
      GO TO 540
C
C     GET HERE IF IR CARD READ
C
   65 IF (DATI(3).NE.DATI(4)) GO TO 70
      IBAD=7
      GO TO 545
   70 DO 75 I=3,4
      IF ((DATI(I).LT.1.).OR.(DATI(I).GT.44.)) IBAD=8
      IF ((DATI(I).LT.1.).OR.(DATI(I).GT.44.)) GO TO 545
   75 CONTINUE
C
C     GET HERE IF DATA OK
C     COUNT IR AND STORE DATA
C
      NIR=NIR+1
      IRJUNC(NIR)=DATI(3)
      ERJUNC(NIR)=DATI(4)
      DO 80 N=1,NIR
      IF (IRJUNC(NIR).EQ.ERJUNC(N)) IBAD=33
      IF (IRJUNC(NIR).EQ.ERJUNC(N)) GO TO 560
      IF ((IRJUNC(NIR).EQ.IRJUNC(N)).AND.(NIR.NE.N)) IBAD=33
      IF ((IRJUNC(NIR).EQ.IRJUNC(N)).AND.(NIR.NE.N)) GO TO 560
      IF ((ERJUNC(NIR).EQ.IRJUNC(N))) IBAD=34
      IF ((ERJUNC(NIR).EQ.IRJUNC(N))) GO TO 560
   80 CONTINUE
      GO TO 500
C
C     GET HERE IF ANC CARD READ
C
   85 INDEX=DATI(3)
      IF ((DATI(3).LT.1.).OR.(DATI(3).GT.44.)) IBAD=6
      IF ((DATI(3).LT.1.).OR.(DATI(3).GT.44.)) GO TO 545
      IF (ICHECK(INDEX).NE.0) IBAD=30
      IF (ICHECK(INDEX).NE.0) GO TO 550
C
C     GET HERE IF DATA OK -- COUNT ANCHOR AND STORE DATA
C
      NANC=NANC+1
      ANJUNC(NANC)=DATI(3)
      ICHECK(INDEX)=1
   90 DO 95 I=1,3
   95 PJUNC(I,INDEX)=DATI(I+3)
      GO TO 500
C
C     GET HERE IF DJNC CARD READ
C
  100 DATI(4)=2
      IF ((DATI(3).LT.1.).OR.(DATI(3).GT.44.)) IBAD=23
      IF ((DATI(3).LT.1.).OR.(DATI(3).GT.44.)) GO TO 545
      IF ((DATI(7).LT.0.).OR.(DATI(8).LT.0.)) IBAD=24
      IF ((DATI(7).LT.0.).OR.(DATI(8).LT.0.)) GO TO 545
      INDEV=INDEV+1
      INDEX=INDEV
      GO TO 500
C
C     GET HERE IF DCAB CARD READ
```

```
C
  105 DO 110 I=1,2
      ID=DATI(4)
      IF (ID.EQ.I) GO TO 115
  110 CONTINUE
      IBAD=18
      GO TO 545
  115 IF ((DATI(3).LT.1.).OR.(DATI(3).GT.22.)) IBAD=17
      IF ((DATI(3).LT.1.).OR.(DATI(3).GT.22.)) GO TO 545
      INDEV=INDEV+1
      INDEX=INDEV
      IF ((INDEX.LT.1).OR.(INDEX.GT.1000)) IBAD=19
      IF ((INDEX.LT.1).OR.(INDEX.GT.1000)) GO TO 545
      IF ((DATI(7).LT.0.).OR.(DATI(8).LT.0.)) IBAD=22
      IF ((DATI(7).LT.0.).OR.(DATI(8).LT.0.)) GO TO 545
      IF ((DATI(4).EQ.2.).AND.(DATI(9).NE.0.)) IBAD=21
      IF ((DATI(4).EQ.2.).AND.(DATI(9).NE.0.)) GO TO 545
      IF ((DATI(4).EQ.1.).AND.(DATI(9).LE.0.)) IBAD=20
      IF ((DATI(4).EQ.1.).AND.(DATI(9).LE.0.)) GO TO 545
      IF (DATI(10).LT.0.) IBAD=22
      IF (DATI(10).LT.0.) GO TO 545
      TDCAB(INDEX)=EX
      GO TO 590
C
C     GET HERE IF CAB CARD READ
C
  120 INDEX=DATI(3)
      IF (IFLG.EQ.0) READ (IREAD,620) STORE
      IF (IFLG.EQ.1) READ (IREAD,645) TDCAB(INDEX)
C
C     SAVE INPUT ON TAPE
C
      IBAD=0
      IFORM=3
      WRITE (ISCR) IFORM,IBAD
      IF (IFLAG.EQ.0) WRITE (ISCR,620) STORE
      IF (IFLAG.EQ.0) DECODE (10,640,STORE) TDCAB(INDEX)
      DECODE (10,640,STORE) TDCAB(INDEX)
      IF ((DATI(3).LT.1.).OR.(DATI(3).GT.22.)) IBAD=9
      IF ((DATI(3).LT.1.).OR.(DATI(3).GT.22.)) GO TO 545
      IF (DATI(4).EQ.DATI(5)) IBAD=10
      IF (DATI(4).EQ.DATI(5)) GO TO 545
      IF ((DATI(4).GT.44.).OR.(DATI(5).GT.44.)) IBAD=11
      IF ((DATI(4).GT.44.).OR.(DATI(5).GT.44.)) GO TO 545
      IF ((DATI(4).LT.1.).OR.(DATI(5).LT.1.)) IBAD=11
      IF ((DATI(4).LT.1.).OR.(DATI(5).LT.1.)) GO TO 545
      IF ((DATI(7).LE.0.).OR.(DATI(8).LE.0.).OR.(DATI(9).LE.0.)) IBAD=12
      IF ((DATI(7).LE.0.).OR.(DATI(8).LE.0.).OR.(DATI(9).LE.0.)) GO TO 5
  145
      IF ((EX.LT.0.).OR.(DATI(10).LT.0.)) IBAD=13
      IF ((EX.LT.0.).OR.(DATI(10).LT.0.)) GO TO 545
      IF ((DATI(10).EQ.0.).AND.(EX.NE.0.)) IBAD=14
      IF ((DATI(10).EQ.0.).AND.(EX.NE.0.)) GO TO 545
      IF ((DATI(10).NE.0.).AND.(EX.EQ.0.)) IBAD=15
      IF ((DATI(10).NE.0.).AND.(EX.EQ.0.)) GO TO 545
      IF ((NSEG.LT.1).OR.(NSEG.GT.50)) IBAD=16
      IF ((NSEG.LT.1).OR.(NSEG.GT.50)) GO TO 545
```

```
      IF (ICAB(INDEX).NE.0) GO TO 555
      ICAB(INDEX)=1
      INDEX=DATI(5)
      IF (ICHECK(INDEX).NE.0) IBAD=31
      IF (ICHECK(INDEX).NE.0) GO TO 550
      ICHECK(INDEX)=1
C
C     GET HERE IF DATA CK
C
      INDEX=DATI(3)
      ZJUNC(INDEX)=DATI(4)
      LJUNC(INDEX)=DATI(5)
  125 NNODE(INDEX)=NSEG+1
      WCAB(INDEX)=DATI(6)
      CDCAB(INDEX)=DATI(7)
      DCAB(INDEX)=DATI(8)
      H(INDEX)=DATI(9)/NSEG
      ECICAB(INDEX)=DATI(10)
      EXPCAB(INDEX)=EX
      GO TO 500
C
C     GET HERE IF DEN CARD READ
C
  130 IF (DATI(3).LE.0.) IBAD=25
      IF (DATI(3).LE.0.) GO TO 545
      IFRHO=IFRHO+1
      IF (IFRHO.GT.1) IBAD=36
      IF (IFRHO.GT.1) GO TO 565
      RHO=DATI(3)
      GO TO 50
C
C     GET HERE IF EOD CARD READ
C
  135 IFEOD=IFEOD+1
      DO 140 J=1,10
  140 DATIT(IROW,J)=DATI(J)
      IRMAX=IROW
      IF (FATE.NE.0.) GO TO 450
      IF (IFLG.EQ.1) GO TO 145
      GO TO 335
  145 IREAD=ISAV1
      IFLG=0
      GO TO 335
C
C     GET HERE IF NJNC CARD READ
C
  150 IF ((DATI(3).LT.2.).OR.(DATI(3).GT.44.)) IBAD=5
      IF ((DATI(3).LT.2.).OR.(DATI(3).GT.44.)) GO TO 545
      IFJNC=IFJNC+1
      IF (IFJNC.GT.1) IBAD=35
      IF (IFJNC.GT.1) GO TO 565
      NCJUNC=DATI(3)
      GO TO 50
C
C     GET HERE IF NCAT CARD READ
C
  155 NCATC=NCATC+1
```

```
      C                                                                 INP 343
      C     DEFINE CURRENT UNITS OPTION AND CONVERSION FACTOR           INP 344
      C                                                                 INP 345
            IUNIT=DATI(10)+1.E-9                                        INP 346
            CUNITS=1.                                                   INP 347
            IF (IUNIT.EQ.1) CUNITS=0.01943                              INP 348
            IF (IUNIT.EQ.2) CUNITS=0.5921                               INP 349
            DEVWT=DATI(8)                                               INP 350
            NSTEPS=1                                                    INP 351
            ISTEP=1                                                     INP 352
            PERCNTV=0.                                                  INP 353
            INCPRNT=0                                                   INP 354
            IF (EX.NE.0.0) NSTEPS=EX                                    INP 355
            IF (FLOAT(NSTEPS).NE.EX.AND.NSTEPS.GT.1) INCPRNT=1          INP 356
            IF (DATI(7).NE.0.0) IPUNCH=8H      YES                      INP 357
            NCCUR=DATI(5)                                               INP 358
            READ (IREAD,620) TITLE                                      INP 359
      C                                                                 INP 360
      C     SAVE INPUT ON TAPE                                          INP 361
      C                                                                 INP 362
            IBAD=0                                                      INP 363
            IFORM=1                                                     INP 364
            WRITE (ISCR) IFORM,IBAD                                     INP 365
            WRITE (ISCR,620) TITLE                                      INP 366
            IF (NDATC.NE.IFEOD) GO TO 615                               INP 367
      C                                                                 INP 368
      C     READ ANGLE IN DEGREES BETWEEN MAGNETIC NORTH AXIS AND X-AXIS OF INP 369
      C     ARRAY REFERENCED COORDINATE SYSTEM, ANGLE IS POSITIVE CLOCKWISE INP 370
      C     AND IS REFERENCED WITH RESPECT TO THE MAGNETIC NORTH AXIS.  INP 371
      C                                                                 INP 372
            PHI=DATI(6)                                                 INP 373
            GO TO 45                                                    INP 374
        160 IFCOMP=0                                                    INP 375
            INDAT=0                                                     INP 376
            IFVEL=0                                                     INP 377
            IFANG=0                                                     INP 378
            IF ((DATI(3).LT.0.0).OR.(DATI(3).GT.3.)) IBAD=26            INP 379
            IF ((DATI(3).LT.0.0).OR.(DATI(3).GT.3.)) GO TO 545          INP 380
            IVOPT=DATI(3)                                               INP 381
            IF (IVOPT.EQ.3) NSTA=DATI(4)                                INP 382
            IF (NDATC.EQ.1) GO TO 165                                   INP 383
            IF (IVOPT.EQ.0) GO TO 180                                   INP 384
            IF (KFLG.EQ.0) GO TO 170                                    INP 385
            IF (IVOPT.EQ.KCUR) GO TO 180                                INP 386
            GO TO 610                                                   INP 387
        165 IF (IVOPT.EQ.0) GO TO 175                                   INP 388
        170 KFLG=1                                                      INP 389
            KCUR=IVOPT                                                  INP 390
            GO TO 180                                                   INP 391
        175 KFLG=0                                                      INP 392
      C                                                                 INP 393
      C     READ ONE INPUT RECORD FROM PARAMETRIC STUDY SOURCE DECK     INP 394
      C                                                                 INP 395
        180 READ (IREAD,620) STORE                                      INP 396
            IF (EOF(IREAD)) 185,190                                     INP 397
        185 CALL HACA()                                                 INP 398
            STOP                                                        INP 399
```

```
C                                                                       INP 400
C     SAVE INPUT ON TAPE                                                INP 401
C                                                                       INP 402
  190 IBAD=0                                                            INP 403
      IFORM=2                                                           INP 404
      WRITE (ISCR) IFORM,IBAD                                           INP 405
      WRITE (ISCR,620) STORE                                            INP 406
      DECODE (80,630,STORE) DATN,EXX,NNSEG                              INP 407
      DO 195 I=1,14                                                     INP 408
      IF (DATN(2).EQ.TEST(I)) GO TO (615,255,255,255,255,615,230,225,315INP 409
     1,615,200,615,615,615), I                                          INP 410
      IF (DATN(2).EQ.4HCPLT) GO TO 235                                  INP 411
      IF (DATN(2).EQ.4HPPLT) GO TO 245                                  INP 412
  195 CONTINUE                                                          INP 413
      CALL SWTCH                                                        INP 414
      GO TO 540                                                         INP 415
C                                                                       INP 416
C     GET HERE IF VEL CARD READ                                         INP 417
C                                                                       INP 418
  200 IFVEL=IFVEL+1                                                     INP 419
      IF (IVOPT.EQ.3) CALL REDVEL (IREAD,IPHNI)                         INP 420
      CALL SWTCH                                                        INP 421
      IF (IVOPT.EQ.3) GO TO 180                                         INP 422
      IF (IVOPT.EQ.0) GO TO 615                                         INP 423
      IF (IFVEL.NE.1) GO TO 210                                         INP 424
      NVSEG=0                                                           INP 425
      DO 205 I=1,25                                                     INP 426
      ZVEL(I)=0.                                                        INP 427
  205 VELZ(I)=0.                                                        INP 428
  210 NVSEG=NVSEG+1                                                     INP 429
      IF (NVSEG.GT.25) IBAD=38                                          INP 430
      IF (NVSEG.GT.25) GO TO 565                                        INP 431
      ZVEL(NVSEG)=DATI(3)                                               INP 432
      DO 215 K=1,NVSEG                                                  INP 433
      IF ((ZVEL(NVSEG).EQ.ZVEL(K)).AND.(K.NE.NVSEG)) IBAD=39            INP 434
      IF ((ZVEL(NVSEG).EQ.ZVEL(K)).AND.(K.NE.NVSEG)) GO TO 565          INP 435
  215 CONTINUE                                                          INP 436
      IF (IVOPT.EQ.2) GO TO 220                                         INP 437
      VELZ(NVSEG)=DATI(4)                                               INP 438
      GO TO 180                                                         INP 439
  220 VELX(NVSEG)=DATI(4)                                               INP 440
      VELY(NVSEG)=DATI(5)                                               INP 441
      GO TO 180                                                         INP 442
C                                                                       INP 443
C     GET HERE IF ANG CARD READ                                         INP 444
C                                                                       INP 445
  225 IFANG=IFANG+1                                                     INP 446
      CALL SWTCH                                                        INP 447
      IF (IVOPT.EQ.0) GO TO 615                                         INP 448
      IF (IFANG.EQ.1) NANG=0                                            INP 449
      IF (DATI(4).LE.0.) IBAD=28                                        INP 450
      IF (DATI(4).LE.0.) GO TO 545                                      INP 451
      IF (DATI(5).LT.DATI(3)) IBAD=29                                   INP 452
      IF (DATI(5).LT.DATI(3)) GO TO 545                                 INP 453
      THETAB=DATI(3)                                                    INP 454
      THETAS=DATI(4)                                                    INP 455
      THETAE=DATI(5)                                                    INP 456
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      NANG=NANG+1                                                       INP 457
      IF (NANG.GT.1) IBAD=40                                            INP 458
      IF (NANG.GT.1) GO TO 565                                          INP 459
      GO TO 180                                                         INP 460
C                                                                       INP 461
C     GET HERE IF COMP CARD READ                                        INP 462
C                                                                       INP 463
  230 IFCOMP=IFCOMP+1                                                   INP 464
      CALL SWITCH                                                       INP 465
      IF (IFCOMP.EQ.1) NCOMP=0                                          INP 466
      IF (DATI(3).LE.0.) IBAD=27                                        INP 467
      IF (DATI(3).LE.0.) GO TO 545                                      INP 468
      NCOMP=NCOMP+1                                                     INP 469
      IF (NCOMP.GT.1) IBAD=37                                           INP 470
      IF (NCOMP.GT.1) GO TO 565                                         INP 471
      COMPO=DATI(3)                                                     INP 472
      NIT=200                                                           INP 473
      IF (DATI(4).NE.0.0) NIT=DATI(4)                                   INP 474
      MXITER=1000                                                       INP 475
      IF (DATI(5).NE.0.0) MXITER=DATI(5)                                INP 476
      GO TO 180                                                         INP 477
C                                                                       INP 478
C     GET HERE TO PLOT VELOCITY FIELD                                   INP 479
C                                                                       INP 480
  235 IF (KPLT.EQ.0) CALL PLOTS (0,0,6LNPFILE)                          INP 481
      KPLT=1                                                            INP 482
      KCPLT=1                                                           INP 483
      CALL SWITCH                                                       INP 484
      ZUP=DATI(3)                                                       INP 485
      ZDN=DATI(4)                                                       INP 486
      DZ=DATI(5)                                                        INP 487
      YIN=DATI(6)                                                       INP 488
      XMIN=DATI(7)                                                      INP 489
      XMAX=DATI(8)                                                      INP 490
      YMIN=DATI(9)                                                      INP 491
      YMAX=DATI(10)                                                     INP 492
      ANG=EXX                                                           INP 493
      IF (ANG.LE.0.0.OR.ANG.GE.180.) ANG=90.                            INP 494
      NY=NNSEG                                                          INP 495
      IF (NY.LE.0) NY=6                                                 INP 496
C                                                                       INP 497
C     FIND MAX AND MIN FOR DEFAULT                                      INP 498
C                                                                       INP 499
      DEFAULT=XMIN+YMIN+XMAX+YMAX                                       INP 500
      IF (DEFAULT.NE.0.) GO TO 180                                      INP 501
      BIG=1.E10                                                         INP 502
      XMIN=BIG                                                          INP 503
      YMIN=BIG                                                          INP 504
      XMAX=-BIG                                                         INP 505
      YMAX=-BIG                                                         INP 506
      DO 240 ISF=1,NANC                                                 INP 507
      ISA=ANJUNC(ISF)                                                   INP 508
      XMIN=AMIN1(XMIN,PJUNC(1,ISA))                                     INP 509
      YMIN=AMIN1(YMIN,PJUNC(2,ISA))                                     INP 510
      XMAX=AMAX1(XMAX,PJUNC(1,ISA))                                     INP 511
  240 YMAX=AMAX1(YMAX,PJUNC(2,ISA))                                     INP 512
      RX=ABS(XMAX-XMIN)                                                 INP 513
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      RY=ABS(YMAX-YMIN)                                                 INP 514
      IF (RY.EQ.0.) YMIN=YMIN-0.15*RX                                   INP 515
      IF (RY.EQ.0.) YMAX=YMAX+0.15*RX                                   INP 516
      IF (RX.EQ.0.) XMIN=XMIN-0.15*RY                                   INP 517
      IF (RX.EQ.0.) XMAX=XMAX+0.15*RY                                   INP 518
      GO TO 180                                                         INP 519
C                                                                       INP 520
C     GET HERE FOR PERSPECTIVE PLOTTING                                 INP 521
C                                                                       INP 522
  245 CALL SWTCH                                                        INP 523
      IFOPT=DATI(3)+.01                                                 INP 524
      SIZE=DATI(4)                                                      INP 525
      TH(1)=DATI(5)                                                     INP 526
      TH(2)=DATI(6)                                                     INP 527
      TH(3)=DATI(7)                                                     INP 528
      DEFAULT=TH(1)+TH(2)+TH(3)                                         INP 529
      IF (DEFAULT.NE.0.0) GO TO 250                                     INP 530
      TH(1)=30.                                                         INP 531
      TH(2)=120.                                                        INP 532
      TH(3)=90.                                                         INP 533
  250 IF (KPLT.EQ.0) CALL PLOTS (0,0,6LNPFILE)                          INP 534
      KPLT=1                                                            INP 535
      KPPLT=1                                                           INP 536
      GO TO 180                                                         INP 537
C                                                                       INP 538
C     GET HERE IF PARAMETERS ARE BEING CHANGED                          INP 539
C     LOCATE RECORD TO BE CHANGED AND BRANCH                            INP 540
C                                                                       INP 541
  255 IF (INDAT.NE.0) GO TO 260                                         INP 542
      READ (INTAPE,660) ((DATIT(I,J),J=1,10),I=1,IRMAX)                 INP 543
      REWIND INTAPE                                                     INP 544
      INDAT=1                                                           INP 545
  260 DO 265 I=1,IRMAX                                                  INP 546
      IROW=I                                                            INP 547
      IF ((DATN(1).EQ.DATIT(IROW,1)).AND.(DATN(2).EQ.DATIT(IROW,2))) GO INP 548
     1TO 270                                                            INP 549
      IF (DATIT(IROW,2).EQ.TEST(9)) GO TO 605                           INP 550
  265 CONTINUE                                                          INP 551
  270 DO 275 J=1,10                                                     INP 552
  275 DATI(J)=DATIT(IROW,J)                                             INP 553
      DO 280 I=1,5                                                      INP 554
      IF (DATN(2).EQ.TEST(I)) GO TO (280,285,290,295,305), I            INP 555
  280 CONTINUE                                                          INP 556
C                                                                       INP 557
C     GET HERE IF ANC CARD READ                                         INP 558
C                                                                       INP 559
  285 IF (DATI(3).NE.DATN(3)) GO TO 605                                 INP 560
      CALL SWTCH                                                        INP 561
      INDEX=DATI(3)                                                     INP 562
      GO TO 90                                                          INP 563
C                                                                       INP 564
C     GET HERE IF DJNC CARD READ                                        INP 565
C                                                                       INP 566
  290 IF (DATI(3).NE.DATN(3)) GO TO 605                                 INP 567
      CALL SWTCH                                                        INP 568
      DATI(4)=2                                                         INP 569
      IF ((DATI(7).LT.0.).OR.(DATI(8).LT.0.)) IHAD=24                   INP 570
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      IF ((DATI(7).LT.0.).OR.(DATI(8).LT.0.)) GO TO 545              INP 571
      GO TO 500                                                      INP 572
C                                                                    INP 573
C     GET HERE IF DCAB CARD READ                                     INP 574
C                                                                    INP 575
  295 IF (DATI(3).NE.DATN(3)) GO TO 605                              INP 576
      IDDCAB(IROW)=EXX                                               INP 577
      IF (((DATI(4).EQ.1).OR.(DATI(4).EQ.2)).AND.((DATN(4).EQ.1).OR.(DATINP 578
     1N(4).EQ.2))) GO TO 300                                         INP 579
      GO TO 605                                                      INP 580
  300 CALL SWTCH                                                     INP 581
      IF ((DATI(4).EQ.2.).AND.(DATI(9).NE.0.)) IBAD=21               INP 582
      IF ((DATI(4).EQ.2.).AND.(DATI(9).NE.0.)) GO TO 545             INP 583
      IF ((DATI(7).LT.0.).OR.(DATI(8).LT.0.)) IBAD=22                INP 584
      IF ((DATI(7).LT.0.).OR.(DATI(8).LT.0.)) GO TO 545              INP 585
      IF ((DATI(4).EQ.1.).AND.(DATI(9).LE.0.)) IBAD=20               INP 586
      IF ((DATI(4).EQ.1.).AND.(DATI(9).LE.0.)) GO TO 545             INP 587
      IF (DATI(10).LT.0.) IBAD=20                                    INP 588
      IF (DATI(10).LT.0.) GO TO 545                                  INP 589
      GO TO 500                                                      INP 590
C                                                                    INP 591
C     GET HERE IF CAB CARD READ                                      INP 592
C                                                                    INP 593
  305 DO 310 I=3,5                                                   INP 594
      IF (DATI(I).NE.DATN(I)) GO TO 605                              INP 595
  310 CONTINUE                                                       INP 596
      CALL SWTCH                                                     INP 597
      EX=EXX                                                         INP 598
      NSEG=NNSEG                                                     INP 599
      INDEX=DATI(3)                                                  INP 600
      READ (IREAD,620) STORE                                         INP 601
C                                                                    INP 602
C     SAVE INPUT ON TAPE                                             INP 603
C                                                                    INP 604
      IBAD=0                                                         INP 605
      IFORM=3                                                        INP 606
      WRITE (ISCR) IFORM,IBAD                                        INP 607
      WRITE (ISCR,620) STORE                                         INP 608
      DECODE (10,640,STORE) IDCAB(INDEX)                             INP 609
      IF ((DATI(7).LE.0.).OR.(DATI(8).LE.0.).OR.(DATI(9).LE.0.)) IBAD=12INP 610
      IF ((DATI(7).LE.0.).OR.(DATI(8).LE.0.).OR.(DATI(9).LE.0.)) GO TO 5INP 611
     145                                                             INP 612
      IF ((EX.LT.0.).OR.(DATI(10).LT.0.)) IBAD=13                    INP 613
      IF ((EX.LT.0.).OR.(DATI(10).LT.0.)) GO TO 545                  INP 614
      IF ((DATI(10).EQ.0.).AND.(EX.NE.0.)) IBAD=14                   INP 615
      IF ((DATI(10).EQ.0.).AND.(EX.NE.0.)) GO TO 545                 INP 616
      IF ((DATI(10).NE.0.).AND.(EX.EQ.0.)) IBAD=15                   INP 617
      IF ((DATI(10).NE.0.).AND.(EX.EQ.0.)) GO TO 545                 INP 618
      IF ((NSEG.LT.1).OR.(NSEG.GT.50)) IBAD=10                       INP 619
      IF ((NSEG.LT.1).OR.(NSEG.GT.50)) GO TO 545                     INP 620
      GO TO 125                                                      INP 621
C                                                                    INP 622
C     GET HERE IF FCD CARD READ                                      INP 623
C                                                                    INP 624
  315 IFEOD=IFEOD+1                                                  INP 625
      IF (FATE.NE.0.) GO TO 45                                       INP 626
      GO TO 340                                                      INP 627
```

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C                                                                       INP 628
C     GET HERE IF LUN CARD READ                                         INP 629
C                                                                       INP 630
  320 INTAPE=DATI(5)                                                    INP 631
      IFLG=DATI(6)                                                      INP 632
      IF ((IFLG.LT.0).OR.(IFLG.GT.1)) IBAD=2                            INP 633
      IF ((IFLG.LT.0).OR.(IFLG.GT.1)) GO TO 545                         INP 634
      ISAV1=DATI(3)                                                     INP 635
      IF (IFLG.EQ.0) IREAD=DATI(3)                                      INP 636
      IF (IFLG.EQ.1) IREAD=DATI(7)                                      INP 637
      OFLG=DATI(8)                                                      INP 638
      IF ((OFLG.LT.0).OR.(OFLG.GT.2)) IBAD=3                            INP 639
      IF ((OFLG.LT.0).OR.(OFLG.GT.2)) GO TO 545                         INP 640
      IF (OFLG.EQ.0) OUTAPE=DATI(4)                                     INP 641
      IF (OFLG.NE.0) OUTAPE=DATI(9)                                     INP 642
      IF ((IPRNT.EQ.IREAD).OR.(IPRNT.EQ.INTAPE).OR.((OFLG.NE.0).AND.(IPRINP 643
     1NT.EQ.OUTAPE)).OR.(INTAPE.EQ.IREAD).OR.(INTAPE.EQ.OUTAPE).OR.(IREAINP 644
     2D.EQ.OUTAPE).OR.((IFLG.EQ.1).AND.(IREAD.EQ.ISAV1))) IBAD=4        INP 645
      IF ((IPRNT.EQ.IREAD).OR.(IPRNT.EQ.INTAPE).OR.((OFLG.NE.0).AND.(IPRINP 646
     1NT.EQ.OUTAPE)).OR.(INTAPE.EQ.IREAD).OR.(INTAPE.EQ.OUTAPE).OR.(IREAINP 647
     2D.EQ.OUTAPE).OR.((IFLG.EQ.1).AND.(IREAD.EQ.ISAV1))) GO TO 545     INP 648
      GO TO 50                                                          INP 649
C                                                                       INP 650
C     GET HERE FOR EOP                                                  INP 651
C                                                                       INP 652
  325 IF (FATE.NE.0.) CALL BADATA                                       INP 653
      IF (OFLG.EQ.0) GO TO 330                                          INP 654
      WRITE (OUTAPE,650) TEST(14)                                       INP 655
  330 IF (FATE.EQ.0.) WRITE (IPRNT,655)                                 INP 656
      IF (KPLT.NE.0) CALL PLOT (1.,1.,999)                              INP 657
      FATE=1.                                                           INP 658
      RETURN                                                            INP 659
C                                                                       INP 660
C     CHECK TO SEE IF SUSPENDED ARRAY SOURCE DECK COMPLETE              INP 661
C                                                                       INP 662
  335 IF ((IFJNC.EQ.0).OR.(IFRHO.EQ.0).OR.(NANC.EQ.0)) GO TO 570        INP 663
      GO TO 395                                                         INP 664
C                                                                       INP 665
C     CHECK TO SEE IF PARAMETRIC STUDY SOURCE DECK COMPLETE             INP 666
C                                                                       INP 667
  340 IF ((IVOPT.EQ.0).OR.(IVOPT.EQ.3)) GO TO 390                       INP 668
      NZL=0                                                             INP 669
      IF (NVSEG.EQ.0) IBAD=54                                           INP 670
      IF (NVSEG.EQ.0) GO TO 575                                         INP 671
      IF (IFVEL.EQ.0) GO TO 370                                         INP 672
      IF (IVOPT.EQ.2) GO TO 355                                         INP 673
C                                                                       INP 674
C     SORT VELOCITY PROFILE BY Z-COORDINATE                             INP 675
C                                                                       INP 676
      DO 345 I=1,NVSEG                                                  INP 677
      K=I                                                               INP 678
      DO 345 J=K,NVSEG                                                  INP 679
      IF (ZVEL(I).LE.ZVEL(J)) GO TO 345                                 INP 680
      TEMP=ZVEL(I)                                                      INP 681
      ZVEL(I)=ZVEL(J)                                                   INP 682
      ZVEL(J)=TEMP                                                      INP 683
      TEMP=VELZ(I)                                                      INP 684
```

```
      VELZ(I)=VELZ(J)
      VELZ(J)=TEMP
  345 CONTINUE
C
C     UNITS CONVERSION
C
      DO 350 I=1,NVSEG
      VELXP(I)=VELZ(I)
      VELYP(I)=0.
      VELZ(I)=VELZ(I)*CUNITS
      VELX(I)=VELZ(I)
  350 VELY(I)=0.
      GO TO 370
C
C     SORT VELOCITY FOR CURRENT OPTION 2
C
  355 DO 360 I=1,NVSEG
      K=I
      DO 360 J=K,NVSEG
      IF (ZVEL(I).LE.ZVEL(J)) GO TO 360
      TEMP=ZVEL(I)
      ZVEL(I)=ZVEL(J)
      ZVEL(J)=TEMP
      TVX=VELX(I)
      TVY=VELY(I)
      VELX(I)=VELX(J)
      VELY(I)=VELY(J)
      VELX(J)=TVX
      VELY(J)=TVY
  360 CONTINUE
C
C     UNITS CONVERSION
C
      DO 365 I=1,NVSEG
      VELXP(I)=VELX(I)
      VELYP(I)=VELY(I)
      AMAG=VELX(I)
      DIR=360.-VELY(I)+PHI
      VELX(I)=COS(DIR*PIP)*AMAG*CUNITS
  365 VELY(I)=SIN(DIR*PIP)*AMAG*CUNITS
  370 INDEX=ANJUNC(1)
      ZANCM=PJUNC(3,INDEX)
      IF (NANC.EQ.1) GO TO 380
      DO 375 N=2,NANC
      INDEX=ANJUNC(N)
      IF (PJUNC(3,INDEX).LT.ZANCM) ZANCM=PJUNC(3,INDEX)
  375 CONTINUE
  380 IF (IVOPT.EQ.1) ZVEL(1)=ZANCM
      DO 385 N=1,NVSEG
      IF (ZVEL(N).LE.ZANCM) NZL=NZL+1
  385 CONTINUE
      IF ((NZL.EQ.0).OR.(NANG.EQ.0)) IBAD=54
      IF ((NZL.EQ.0).OR.(NANG.EQ.0)) GO TO 575
  390 IF (NCOMP.EQ.0) IBAD=53
      IF (NCOMP.EQ.0) GO TO 575
      IF (INDAT.NE.0) GO TO 415
      RETURN
```

```
      C
      C     CHECK ON CONTINUITY OF CABLE NUMBERING AND COUNT CABLES
      C
        395 NCAB=ICAB(22)
            DO 400 N=1,21
            NCAB=NCAB+ICAB(N)
            J=ICAB(N)-ICAB(N+1)
            IF (J.LT.0) GO TO 580
        400 CONTINUE
            IF (NCAB.EQ.0) GO TO 580
      C
      C     CHECK ON CONTINUITY OF JUNCTION NUMBERING AND COUNT JUNCTIONS
      C
            NJUNC=ICHECK(44)
            DO 405 N=1,43
            NJUNC=NJUNC+ICHECK(N)
            J=ICHECK(N)-ICHECK(N+1)
            IF (J.LT.0) GO TO 585
        405 CONTINUE
      C
      C     SORT DEVICES ON CABLE NO.(DATI(3))
      C     AND DISTANCE FROM 0 JUNCTION(DATI(10))
      C
            NDEV=INDEV
            CALL SORT (NDEV,INTAPE)
            IF (FATE.EQ.0.) GO TO 410
            GO TO 530
      C
      C     GET HERE IF ARRAY NUMBERED CORRECTLY
      C     CHECK TO SEE IF NIR CONSISTENT
      C
        410 NIRC=NCAB+NANC-NOJUNC
            IF (NIR.NE.NIRC) GO TO 590
      C
      C     GET HERE TO MAKE FINAL CHECK ON INTAPE
      C
        415 I=1
        420 DO 425 J=1,10
        425 DATI(J)=DATII(I,J)
            I=I+1
            IF (DATI(2).EQ.TEST(1)) GO TO 430
            IF (DATI(2).EQ.TEST(3)) GO TO 435
            IF (DATI(2).EQ.TEST(4)) GO TO 440
            IF (DATI(2).EQ.TEST(5)) GO TO 445
            IF (DATI(2).EQ.TEST(9)) GO TO 450
            GO TO 420
      C
      C     GET HERE FOR IR
      C
        430 ID1=DATI(3)
            ID2=DATI(4)
            IF (ID1.LE.NOJUNC) IBAD=45
            IF (ID1.LE.NOJUNC) GO TO 595
            IF (ID2.GT.NOJUNC) IBAD=46
            IF (ID2.GT.NOJUNC) GO TO 595
            IF (ID1.GT.NJUNC) IBAD=47
            IF (ID1.GT.NJUNC) GO TO 595
```

```
      GO TO 420
C
C     GET HERE FOR DJNC
C
  435 ID=DATI(3)
      IF (ID.GT.NJUNC) IBAD=51
      IF (ID.GT.NJUNC) GO TO 595
      GO TO 420
C
C     GET HERE FOR DCAB
C
  440 ID=DATI(3)
      IF (ID.GT.NCAB) IBAD=49
      IF (ID.GT.NCAB) GO TO 595
      PL=H(ID)*(NNODE(ID)-1)
      IF (DATI(10).GE.HL) IBAD=50
      IF (DATI(10).GE.HL) GO TO 595
      GO TO 420
C
C     GET HERE FOR CAB
C
  445 ID=DATI(4)
      IF (ID.GT.NJUNC) IBAD=48
      IF (ID.GT.NJUNC) GO TO 595
      GO TO 420
C
C     GET HERE FOR EOD
C
  450 WRITE (INTAPE,660) ((DATII(I,J),J=1,10),I=1,IRMAX)
      REWIND INTAPE
      IF (NDATC.NE.0.AND.FATE.EQ.0.) RETURN
      IF (FATE.EQ.0.) GO TO 455
      GO TO 50
C
C     GET HERE IF ALL OK AND CALCULATE PATH
C     K IS CABLE COUNTER
C
  455 K=0
C
C     LOOP=1 LOOKING FOR CABLES LEAVING ANCHORS
C
      LOOP=1
C
C     JMINP REMEMBERS FIRST VALUE OF K ON A LEVEL OF TREE
C
      JMINP=1
C
C     JMAX REMEMBERS NUMBER OF CABLES ON A LEVEL OF TOPOGRAPHIC TREE
C
      JMAX=NANC
      IF (LOOP.EQ.1) GO TO 465
  460 JMAX=K
      IF ((LOOP.EQ.1).AND.(K.NE.1)) GO TO 600
      IF ((LOOP.EQ.2).AND.(JMIN.EQ.JMINP)) GO TO 600
      IF (K.EQ.NCAB) GO TO 50
      LOOP=2
  465 JMIN=JMINP
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            DC 495 J=JMIN,JMAX                                          INP 856
      C                                                                 INP 857
      C     LOOKING FOR CABLES LEAVING A JUNCTION                       INP 858
      C                                                                 INP 859
            DC 490 N=1,NCAB                                             INP 860
            GC TO (470,475), LOOP                                       INP 861
        470 IF (ZJUNC(N).EQ.AKJUNC(J)) GO TO 480                        INP 862
            GC TO 490                                                   INP 863
        475 IPATHJ=PATH(J)                                              INP 864
            IF (ZJUNC(N).EQ.LJUNC(IPATHJ)) GO TO 480                    INP 865
            GC TO 490                                                   INP 866
      C                                                                 INP 867
      C     GET HERE IF CABLE N STARTS AT JUNCTION M                    INP 868
      C                                                                 INP 869
        480 K=K+1                                                       INP 870
            PATH(K)=N                                                   INP 871
            GC TO (490,485), LOOP                                       INP 872
      C                                                                 INP 873
      C     REMEMBER HERE FIRST VALUE OF K ON TREE LEVEL                INP 874
      C                                                                 INP 875
        485 IF (JMAX.EQ.(K-1)) JMINP=K                                  INP 876
        490 CONTINUE                                                    INP 877
        495 CONTINUE                                                    INP 878
            GC TO 460                                                   INP 879
      C                                                                 INP 880
      C     PUT DATA INTO DATA ARRAY                                    INP 881
      C                                                                 INP 882
        500 IF (IFEOD.NE.0) GO TO 515                                   INP 883
            IF ((DATI(2).EQ.TEST(3)).OR.(DATI(2).EQ.TEST(4))) GO TO 505 INP 884
            GC TO 515                                                   INP 885
        505 ID=INDEV                                                    INP 886
            DC 510 J=1,10                                               INP 887
            DATIT(IROW,J)=DATIT(ID,J)                                   INP 888
        510 DATIT(ID,J)=DATI(J)                                         INP 889
            GO TO 525                                                   INP 890
        515 DC 520 J=1,10                                               INP 891
        520 DATIT(IROW,J)=DATI(J)                                       INP 892
            IF (IFEOD.NE.0) GO TO 180                                   INP 893
        525 IROW=IROW+1                                                 INP 894
            IF (IROW.LE.2150) GO TO 50                                  INP 895
            WRITE (IPRNT,665)                                           INP 896
            GC TO 50                                                    INP 897
      C                                                                 INP 898
      C     THIS SECTION GENERATES ALL ERROR MESSAGES                   INP 899
      C                                                                 INP 900
        530 FATE=1.                                                     INP 901
            IFORM=4                                                     INP 902
            WRITE (ISCR) IFORM,IBAD                                     INP 903
        535 IF (NDATC.EQ.0) GC TO 50                                    INP 904
            GC TO 180                                                   INP 905
        540 IER=0                                                       INP 906
            IBAD=1                                                      INP 907
            GC TO 530                                                   INP 908
        545 IER=1                                                       INP 909
            GC TO 530                                                   INP 910
        550 IER=2                                                       INP 911
            GC TO 530                                                   INP 912
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  555 IER=3                                          INP 913
      IBAD=32                                        INP 914
      GO TO 530                                      INP 915
  560 IER=4                                          INP 916
      GO TO 530                                      INP 917
  565 IER=6                                          INP 918
      GO TO 530                                      INP 919
  570 IER=7                                          INP 920
      FATE=1                                         INP 921
      IFORM=5                                        INP 922
      IBAD=41                                        INP 923
      WRITE (ISCR) IFORM,IBAD                        INP 924
      WRITE (ISCR) IFJNC,IFRHO,NANC                  INP 925
      GO TO 535                                      INP 926
  575 IER=14                                         INP 927
      FATE=1                                         INP 928
      IFORM=6                                        INP 929
      WRITE (ISCR) IFORM,IBAD                        INP 930
      WRITE (ISCR) NCOMP,IVOPT,NVSEG,NZL,NANG        INP 931
      GO TO 535                                      INP 932
  580 IER=8                                          INP 933
      FATE=1                                         INP 934
      IBAD=42                                        INP 935
      IFORM=7                                        INP 936
      WRITE (ISCR) IFORM,IBAD                        INP 937
      WRITE (ISCR) (ICAB(I),I=1,22)                  INP 938
      GO TO 535                                      INP 939
  585 IER=9                                          INP 940
      FATE=1                                         INP 941
      IBAD=43                                        INP 942
      IFORM=8                                        INP 943
      WRITE (ISCR) IFORM,IBAD                        INP 944
      WRITE (ISCR) (ICHECK(I),I=1,44)                INP 945
      GO TO 535                                      INP 946
  590 IER=11                                         INP 947
      FATE=1                                         INP 948
      IBAD=44                                        INP 949
      IFORM=9                                        INP 950
      WRITE (ISCR) IFORM,IBAD                        INP 951
      WRITE (ISCR) NCAB,NANC,NOJUNC,NIRC,NIR         INP 952
      GO TO 535                                      INP 953
  595 IER=12                                         INP 954
      GO TO 530                                      INP 955
  600 IER=13                                         INP 956
      FATE=1                                         INP 957
      IBAD=52                                        INP 958
      GO TO 530                                      INP 959
  605 DATI(1)=DAIN(1)                                INP 960
      DATI(2)=DAIN(2)                                INP 961
  610 IER=15                                         INP 962
      IBAD=55                                        INP 963
      GO TO 530                                      INP 964
  615 IER=16                                         INP 965
      IBAD=56                                        INP 966
      IF (IFFOU.LG.0) GO TO 53                       INP 967
      DATI(1)=DAIN(1)                                INP 968
      DATI(2)=DAIN(2)                                INP 969
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          GO TO 530                                          INP 970
    C                                                        INP 971
     620 FORMAT (8A10)                                       INP 972
     625 FORMAT (A5,A3)                                      INP 973
     630 FORMAT (F4.0,A4,8F8.0,F5.0,I3)                      INP 974
     635 FORMAT (F4.0,A4,8E15.8,/E12.5,I3)                   INP 975
     640 FORMAT (10F8.0)                                     INP 976
     645 FORMAT (8E15.8)                                     INP 977
     650 FORMAT (A4,I4,3E15.8)                               INP 978
     655 FORMAT (1H1,18HANALYSIS COMPLETED)                  INP 979
     660 FORMAT (F4.0,A4,8E15.8)                             INP 980
     665 FORMAT (6X,2H17,18X,45HCOMMON/B1/ BOUND EXCEEDED.  SEE USERS MANUAINP 981
        1L.)                                                 INP 982
         END                                                 INP 983-
```

CARD NR.	SEVERITY	DETAILS	DIAGNOSIS OF PROBLEM
861	I		AN IF STATEMENT MAY BE MORE EFFICIENT THAN A 2 OR 3 BRANCH COMPUTED GO TO STATEMENT.
872	I		AN IF STATEMENT MAY BE MORE EFFICIENT THAN A 2 OR 3 BRANCH COMPUTED GO TO STATEMENT.

```
      *DECK PHSOUT
            SUBROUTINE PHSOUT
      C
      C     THIS ROUTINE GENERATES INFORMATION CONCERNING THE PHYSICAL
      C     CHARACTERISTICS OF THE STRUCTURAL CABLE ARRAY.
      C
            COMMON /B3/ VELX(25),VELY(25)
            COMMON /B1/ FEJUNC,IR,DELTAI,DELTA,IRS,TFJUNC,E,ES,FCAB,RCAB,JUMP,
           1PJUNCS,PCAB,PCABE,PCABO,RCABO,THETA,PJUNCO
            COMMON /B2/ NCAB,NNODE,ERJUNC,IRJUNC,DATI,DATN,H,PJUNC,CDCAB,DCAB,
           1FATE,NANC,ANJUNC,IREAD,IPRNT,INTAPE,OUTAPE,ITIME,IFLG,OFLG,NIR,THE
           2TAS,THETAE,COMPD,THETAB,NJUNC,RHO,TEST,NVSEG,ZVEL,VELZ,PIP,ECICAB,
           3EXPCAB,ZJUNC,LJUNC,PATH,ICAB,IVOPT,WCAB,IDEV,ICHECK,NDEV,NDATC
            COMMON /TANGRG/ IDCAB(22),TDDCAB(1000)
            COMMON /TITL/ TITLE(8),PHI
            COMMON /PL/ IPUNCH,IPNCH,TITLEM(8),DEVWT
            DIMENSION FEJUNC(3,44), IR(3,44), IRS(3,44), TFJUNC(3,44), PJUNCO(
           13,44)
            DIMENSION FCAB(3,51,22), RCAB(3,51,22), PJUNCS(3,44), PCAB(3,51,22
           1)
            DIMENSION PCABE(3,51,22), PCABO(3,51,22), RCABO(3,51,22)
            DIMENSION NNODE(22), ERJUNC(44), IRJUNC(44), DATI(10), DATN(10), H
           1(22)
            DIMENSION PJUNC(3,44), CDCAB(22), DCAB(22), ANJUNC(44), TEST(14)
            DIMENSION ZVEL(25), VELZ(25), ECICAB(22), EXPCAB(22), ZJUNC(22)
            DIMENSION LJUNC(22), PATH(22), ICAB(22), WCAB(22), IDEV(1000)
            DIMENSION ICHECK(44)
            INTEGER OUTAPE,ZJUNC,ERJUNC,ANJUNC,OFLG
            INTEGER PATH
            REAL IR,IFS
            WRITE (IPRNT,40) TITLEM
            IF (NDATC.NE.0) WRITE (IPRNT,45) TITLE
            WRITE (IPRNT,50)
            WRITE (IPRNT,55) PHI
            IF (PHI.NE.0) WRITE (IPRNT,60)
            IF (PHI.EQ.0) WRITE (IPRNT,65)
            WRITE (IPRNT,70)
            WRITE (IPRNT,75) NANC
            DO 5 N=1,NANC
            INDEX=ANJUNC(N)
          5 WRITE (IPRNT,80) INDEX,(PJUNC(I,INDEX),I=1,3)
            NCJUNC=NCAB+NANC-NIR
            WRITE (IPRNT,85) NCJUNC
            WRITE (IPRNT,90) NIR
            IF (NIR.EQ.0) GO TO 15
            DO 10 N=1,NIR
         10 WRITE (IPRNT,95) IRJUNC(N),ERJUNC(N)
         15 WRITE (IPRNT,100) NCAB
            DO 20 N=1,NCAB
            NSEG=NNODE(N)-1
            PL=H(N)*NSEG
         20 WRITE (IPRNT,105) N,ZJUNC(N),LJUNC(N),PL,DCAB(N),WCAB(N),CDCAB(N),
           1ECICAB(N),EXPCAB(N),NSEG,IDCAB(N)
            WRITE (IPRNT,110)
         25 READ (INTAPE,115) (DATI(I),I=1,10)
            IF (DATI(2).EQ.TEST(3)) GO TO 30
            IF (DATI(2).EQ.TEST(9)) GO TO 35
```

```
      GO TO 25                                                          PHS  58
   30 JUNC=DATI(3)                                                      PHS  59
      WRITE (IPRNT,120) JUNC,(DATI(K),K=6,8)                            PHS  60
      GO TO 25                                                          PHS  61
   35 REWIND INTAPE                                                     PHS  62
      WRITE (IPRNT,125) NDEV                                            PHS  63
      WRITE (IPRNT,130) CONRD                                           PHS  64
      IF (OFLG.NE.0) WRITE (IPRNT,135) NDAIC                            PHS  65
      RETURN                                                            PHS  66
C                                                                       PHS  67
   40 FORMAT (1H1,8A10)                                                 PHS  68
   45 FORMAT (//1X,8A10)                                                PHS  69
   50 FORMAT (///,55H PHYSICAL CHARACTERISTICS OF THE STRUCTURAL CABLE APHS  70
     1RRAY)                                                             PHS  71
   55 FORMAT (//,5H PHI=,F10.2)                                         PHS  72
   60 FORMAT (//,117H THE ANGLE PHI IS THE ANGLE BETWEEN THE MAGNETIC NOPHS  73
     1RTH AXIS AND THE X-AXIS OF THE ARRAY REFERENCED COORDINATE SYSTEM.PHS  74
     2/128H THE ANGLE IS GIVEN IN DEGREES AND IS POSITIVE  FOR A  CLOCKWPHS  75
     3ISE ROTATION OF THE X-AXIS WITH RESPECT TO THE MAGNETIC NORTH AXISPHS  76
     4.)                                                                PHS  77
   65 FORMAT (//,81H SINCE PHI=0, THE MAGNETIC AND ARRAY REFERENCED COORPHS  78
     1DINATE SYSTEMS ARE IDENTICAL.)                                    PHS  79
   70 FORMAT (//,94H ALL X,Y,Z RESULTS  AND DISPLACEMENTS ARE GIVEN IN TPHS  80
     1ERMS OF THE ARRAY FIXED COORDINATE SYSTEM.)                       PHS  81
   75 FORMAT (///,19H NO. OF ANCHORS IS ,I2,//5X,64HJUNCTION NO.   X-COPHS  82
     1ORDINATE      Y-COORDINATE       Z-COORDINATE)                    PHS  83
   80 FORMAT (10X,I2,4X,3(5X,F10.2,3X))                                 PHS  84
   85 FORMAT (//,39H NO. OF JUNCTIONS IN ORIGINAL ARRAY IS ,I2)         PHS  85
   90 FORMAT (//,39H NO. OF CUTS MADE IN ORIGINAL ARRAY IS ,I2//1H ,2(5XPHS  86
     1,12HJUNCTION NO.),/,8X,6HOF CUT,6X,17HAT WHICH CUT MADE)          PHS  87
   95 FORMAT (10X,I2,15X,I2)                                            PHS  88
  100 FORMAT (//,18H NO. OF CABLES IS ,I2,//5X,16HCABLE   S=0   S=L,41X,9PHS  89
     1HNORM DRAG,16X,22HCONSTITUTIVE     NO. OF,5X,9HTANG DRAG/,6X,3HNO.,PHS  90
     21X,2(2X,4HJUNC),3X,6HLENGTH,03X,8HDIAMETER,3X,13HWEIGHT/LENGTH,3X,PHS  91
     311HCOEFFICIENT,3X,8HRIGIDITY,6X,8HEXPONENT,5X,8HELEMENTS,3X,11HCOEPHS  92
     4FFICIENT)                                                         PHS  93
  105 FORMAT (5X,I2,5X,I2,4X,I2,1X,F9.2,3(3X,F7.3,4X),F10.0,7X,F6.3,9X,IPHS  94
     12,6X,F11.3)                                                       PHS  95
  110 FORMAT (//,63H PROPERTIES OF THE DEVICES LOCATED AT JUNCTIONS ARE PHS  96
     1AS FOLLOWS ,//6X,6HDEVICE,10X,6HDEVICE,9X,11HDEVICE DRAG,4X,14HDEVPHS  97
     2ICE FRONTAL,/,5X,9HJUNC. NO.,8X,6HWEIGHT,9X,11HCOEFFICIENT,9X,4HARPHS  98
     3EA)                                                               PHS  99
  115 FORMAT (F4.0,A4,8E15.8)                                           PHS 100
  120 FORMAT (8X,I2,9X,F10.2,6X,F10.3,6X,F10.2)                         PHS 101
  125 FORMAT (//,32H TOTAL NO. OF INDEXED DEVICES IS,I4)                PHS 102
  130 FORMAT (//,35H ACCURACY REQUIRED IN CALCULATIONS IS ,F8.4)        PHS 103
  135 FORMAT (//,30H DEVICE LOCATION OUTPUT RECORD,I3,21H REFERS TO THISPHS 104
     1 ARRAY)                                                           PHS 105
      END                                                               PHS 106-
```

```
*DECK RPOLY
      SUBROUTINE RPOLY (C,RR,RI)
C
C     THIS ROUTINE FINDS REAL ROOTS OF POLYNOMIAL EQUATIONS UP TO
C     C(4)*(X**3) + C(3)*(X**2) + C(2)*X + C(1) = 0  FOR USE IN
C     EVALUATING MAXIMUM CABLE DISPLACEMENTS AND TENSION EXTREMA
C
C     REAL PARTS OF ROOTS ARE PLACED IN RR, IMAGINARY PARTS IN RI
C     SINCE ONLY REAL ROOTS ARE OF INTEREST, ALL NON-REAL OR
C     NON-EXISTING ROOTS RETURN RR=0 , RI=1
C
      DIMENSION C(4), RR(3), RI(3)
      IF (C(4).NE.0.) GO TO 40
      IF (C(3).NE.0.) GO TO 30
      IF (C(2).NE.0.) GO TO 15
C
C     GET HERE IF EQUATION IDENTICALLY SATISFIED
C
    5 DO 10 I=1,3
      RR(I)=0.
   10 RI(I)=1.
      RETURN
C
C     GET HERE IF EQUATION LINEAR
C
   15 RR(1)=-C(1)/C(2)
      RI(1)=0.
   20 DO 25 I=2,3
      RR(I)=0.
   25 RI(I)=1.
      RETURN
C
C     GET HERE IF EQUATION QUADRATIC
C
   30 DISC=C(2)**2-4.*C(1)*C(3)
      IF (DISC.GE.0.) GO TO 35
      GO TO 5
   35 RR(1)=(-C(2)+SQRT(DISC))/(2.*C(3))
      RI(1)=0.
      RR(2)=(-C(2)-SQRT(DISC))/(2.*C(3))
      RI(2)=0.
      RR(3)=0.
      RI(3)=1.
      RETURN
C
C     GET HERE IF EQUATION CUBIC
C
   40 P=C(3)/C(4)
      Q=C(2)/C(4)
      R=C(1)/C(4)
      A=(3.*Q-P**2)/3.
      B=(2.*P**3-9.*P*Q+27.*R)/27.
      DISC=(B**2)/4.+(A**3)/27.
       F (DISC) 50,45,45
   45 DISC=SQRT(DISC)
      IF (B/2..EQ.DISC) CAPA=0.
      IF (B/2..NE.DISC) CAPA=(((-B/2.+DISC)**4)**(1./3.))/(-B/2.+DISC)
```

```
      CAPB=(((-B/2.-DISC)**6)**(1./3.))/(-B/2.-DISC)               RPO  58
      RR(1)=CAPA+CAPB-P/3.                                         RPO  59
      RI(1)=0.                                                     RPO  60
      IF (DISC.GT.0.) GO TO 20                                     RPO  61
      RR(2)=-CAPA-P/3.                                             RPO  62
      RI(2)=0.                                                     RPO  63
      RR(3)=RR(2)                                                  RPO  64
      RI(3)=0.                                                     RPO  65
      RETURN                                                       RPO  66
   50 DISC=2.*SQRT(-A/3.)                                          RPO  67
      PHI=ACOS((+3.*B)/(A*DISC))/3.                                RPO  68
      RR(1)=-P/3.+DISC*COS(PHI)                                    RPO  69
      RR(2)=-P/3.+DISC*COS(PHI+3.14159265*(2./3.))                 RPO  70
      RR(3)=-P/3.+DISC*COS(PHI+3.14159265*(4./3.))                 RPO  71
      RI(1)=0.                                                     RPO  72
      RI(2)=0.                                                     RPO  73
      RI(3)=0.                                                     RPO  74
      RETURN                                                       RPO  75
      END                                                          RPO  76-
```

```
      *DECK SPACE                                                         SPA    1
            FUNCTION SPACE (I)                                            SPA    2
      C                                                                   SPA    3
      C     THIS ROUTINE CALCULATES THE LOCATION IN SPACE                 SPA    4
      C     OF ANY POINT ON THE ARRAY                                     SPA    5
      C                                                                   SPA    6
            COMMON /B3/ VELX(25),VELY(25)                                 SPA    7
            COMMON /B1/ FEJUNC,IR,DELTAI,DELTA,IRS,TFJUNC,E,ES,FCAB,RCAB,JUMP,SPA    8
           1FJUNCS,PCAB,PCABE,PCABO,RCABO,THETA,PJUNCO                    SPA    9
            COMMON /B2/ NCAB,NNODE,ERJUNC,IRJUNC,DATI,DATN,H,PJUNC,CDCAB,DCAB,SPA   10
           1FATE,NANC,ANJUNC,IREAD,IPRNT,INTAPE,OUTAPE,ITIME,IFLG,OFLG,NIR,THESPA   11
           2TAS,THETAE,CORPD,THETAB,NJUNC,RHO,TEST,NVSEG,ZVEL,VELZ,PIP,ECICAB,SPA   12
           3EXPCAB,ZJUNC,LJUNC,PATH,ICAB,IVOPT,WCAB,IDEV,ICHECK,NDEV,NDATC    SPA   13
            DIMENSION FEJUNC(3,44), IR(3,44), IRS(3,44), TFJUNC(3,44), PJUNCO(SPA   14
           13,44)                                                         SPA   15
            DIMENSION FCAB(3,51,22), RCAB(3,51,22), PJUNCS(3,44), PCAB(3,51,22SPA   16
           1)                                                             SPA   17
            DIMENSION PCABE(3,51,22), PCABO(3,51,22), RCABO(3,51,22)      SPA   18
            DIMENSION NNODE(22), ERJUNC(44), IRJUNC(44), DATI(10), DATN(10), HSPA   19
           1(22)                                                          SPA   20
            DIMENSION PJUNC(3,44), CDCAB(22), DCAB(22), ANJUNC(44), TEST(14)  SPA   21
            DIMENSION ZVEL(25), VELZ(25), ECICAB(22), EXPCAB(22), ZJUNC(22)   SPA   22
            DIMENSION LJUNC(22), PATH(22), ICAB(22), WCAB(22), IDEV(1000)     SPA   23
            DIMENSION ICHECK(44)                                          SPA   24
            INTEGER OUTAPE,ZJUNC,ERJUNC,ANJUNC,OFLG                       SPA   25
            INTEGER PATH                                                  SPA   26
            REAL IR,IRS                                                   SPA   27
            IF (DATI(2).EQ.TEST(3)) GO TO 5                               SPA   28
            IF (DATI(2).EQ.TEST(4)) GO TO 10                              SPA   29
      C                                                                   SPA   30
      C     GET HERE IF JUNCTION POINT                                    SPA   31
      C                                                                   SPA   32
          5 K=DATI(3)                                                     SPA   33
            SPACE=PJUNC(I,K)                                              SPA   34
            RETURN                                                        SPA   35
      C                                                                   SPA   36
      C     GET HERE IF POINT ON A CABLE                                  SPA   37
      C                                                                   SPA   38
         10 N=DATI(3)                                                     SPA   39
            M=(DATI(10)/H(N))+1                                           SPA   40
      C                                                                   SPA   41
      C     CALCULATE DISTANCE, SIGMA, OF POINT FROM NODE M               SPA   42
      C                                                                   SPA   43
            SIGMA=DATI(10)-(M-1)*H(N)                                     SPA   44
      C                                                                   SPA   45
      C     CALCULATE EXTRAPOLATION QUANTITIES                            SPA   46
      C                                                                   SPA   47
            EM=EXCAB(M,N)*RCAB(I,M,N)/TCAB(M,N)                           SPA   48
            EM1=EXCAB(M+1,N)*RCAB(I,M+1,N)/TCAB(M+1,N)                    SPA   49
      C                                                                   SPA   50
      C     CALCULATE LOCATION                                            SPA   51
      C                                                                   SPA   52
            SPACE=PCAB(I,M,N)+EM*SIGMA+((EM1-EM)/H(N))*(SIGMA**2)/2.      SPA   53
            RETURN                                                        SPA   54
            END                                                           SPA   55-
```

```
      *DECK START                                                       STA    1
            SUBROUTINE START                                            STA    2
      C                                                                 STA    3
      C     THIS ROUTINE CALCULATES THE INITIAL GUESSES AT THE IMAGINARY STA    4
      C     AND EQUILIBRATING REACTIONS AND THE INITIAL DELTA BASED ON   STA    5
      C     THE TOTAL WEIGHT OF THE ARRAY                                STA    6
      C                                                                 STA    7
            COMMON /B3/ VELX(25),VELY(25)                               STA    8
            COMMON /B1/ FEJUNC,IR,DELTAI,DELTA,IRS,TFJUNC,E,ES,FCAB,RCAB,JUMP,STA    9
           1PJUNCS,PCAB,PCABE,PCABO,RCABO,THETA,PJUNCO                  STA   10
            COMMON /B2/ NCAB,NNODE,ERJUNC,IRJUNC,DATI,DATN,F,PJUNC,CDCAB,DCAB,STA   11
           1FATE,NANC,ANJUNC,IREAD,IPRNT,INTAPE,OUTAPE,ITIME,IFLG,OFLG,NIR,THESTA   12
           2TAS,THETAE,COMPD,THETAB,HJUNC,RHO,TEST,NVSEG,ZVEL,VELZ,PIP,ECICAB,STA   13
           3EXPCAB,ZJUNC,LJUNC,PATH,ICAB,IVOPT,WCAB,IDEV,ICHECK,NDEV,NDATC  STA   14
            DIMENSION FEJUNC(3,44), IR(3,44), IRS(3,44), TFJUNC(3,44), PJUNCO(STA   15
           13,44)                                                       STA   16
            DIMENSION FCAB(3,51,22), RCAB(3,51,22), PJUNCS(3,44), PCAB(3,51,22STA   17
           1)                                                           STA   18
            DIMENSION PCABE(3,51,22), PCABO(3,51,22), RCABO(3,51,22)    STA   19
            DIMENSION NNODE(22), ERJUNC(44), IRJUNC(44), DATI(10), DATN(10), HSTA   20
           1(22)                                                        STA   21
            DIMENSION PJUNC(3,44), CDCAB(22), DCAB(22), ANJUNC(44), TEST(14)  STA   22
            DIMENSION ZVEL(25), VELZ(25), ECICAB(22), EXPCAB(22), ZJUNC(22)   STA   23
            DIMENSION LJUNC(22), PATH(22), ICAB(22), WCAB(22), IDEV(1000)     STA   24
            DIMENSION ICHECK(44)                                        STA   25
            INTEGER OUTAPE,ZJUNC,ERJUNC,ANJUNC,OFLG                     STA   26
            INTEGER PATH                                                STA   27
            REAL IR,IRS                                                 STA   28
            WEIGHT=0.                                                   STA   29
            DO 5 J=1,NJUNC                                              STA   30
          5 WEIGHT=WEIGHT+FEJUNC(3,J)                                   STA   31
            DO 10 N=1,NCAB                                              STA   32
            INNN=NNODE(N)-1                                             STA   33
            DO 10 M=1,INNN                                              STA   34
         10 WEIGHT=WEIGHT+FCAB(3,M,N)                                   STA   35
            DO 15 N=1,NIR                                               STA   36
            KER=ERJUNC(N)                                               STA   37
            DO 15 I=1,3                                                 STA   38
         15 IR(I,KER)=0.                                                STA   39
            DO 20 N=1,NIR                                               STA   40
            KIR=IRJUNC(N)                                               STA   41
            KER=ERJUNC(N)                                               STA   42
            IR(1,KIR)=0.                                                STA   43
            IR(2,KIR)=0.                                                STA   44
            IR(3,KIR)=-WEIGHT/(NIR+1.101)                               STA   45
         20 IR(3,KER)=IR(3,KER)-IR(3,KIR)                               STA   46
            DELTAI=ABS(WEIGHT)/(NIR+1)                                  STA   47
            RETURN                                                      STA   48
            END                                                         STA   49
```

```
*DECK STROUT
      SUBROUTINE STROUT
C
C     THIS ROUTINE GENERATES THE ARRAY STRUCTURAL OUTPUT
C
      COMMON /B3/ VELX(25),VELY(25)
      COMMON /B1/ FEJUNC,IR,DELTAI,DELTA,IRS,TFJUNC,E,ES,FCAB,HCAB,JUMP,
     1PJUNCS,PCAB,PCABE,PCABO,RCABO,THETA,PJUNCO
      COMMON /B2/ NCAB,NNODE,ERJUNC,IRJUNC,DATI,DATN,H,PJUNC,CDCAB,DCAB,
     1FATE,NANC,ANJUNC,IREAD,IPRNT,INTAPE,OUTAPE,ITIME,IFLG,OFLG,NIR,THE
     2TAS,THETAE,COMPO,THETAB,NJUNC,RHO,TEST,NVSEG,ZVEL,VELZ,PIP,ECICAB,
     3EXPCAB,ZJUNC,LJUNC,PATH,ICAB,IVOPT,WCAB,IDEV,ICHECK,NDEV,NDATC
      COMMON /CVEL/ VMAG(25,4),VDIR(25,4),ZPT(25,4),XPT(4),YPT(4),NPPS(4
     1),NSTA
      COMMON /IVEL/ IFVEL
      COMMON /PCUR/ XNPT(4),YWPT(4)
      COMMON /TANDRG/ TDCAB(22),TUDCAB(1000)
      COMMON /TITL/ TITLE(8),PHI,CUNITS,IUNIT,VELXP(25),VELYP(25)
      COMMON /PC/ IPUNCH,IPNCH,TITLEM(8),DEVWT
      COMMON /KITER/ KOUNTR,NIT,MAITER,NSTEPS,ISTEP,PERCNTV,INCPRNT
      DIMENSION FEJUNC(3,44), IR(3,44), IRS(3,44), TFJUNC(3,44), PJUNCO(
     13,44)
      DIMENSION FCAB(3,51,22), HCAB(3,51,22), PJUNCS(3,44), PCAB(3,51,22
     1)
      DIMENSION PCABE(3,51,22), PCABO(3,51,22), RCABO(3,51,22)
      DIMENSION NNODE(22), ERJUNC(44), IRJUNC(44), DATI(10), DATN(10), H
     1(22)
      DIMENSION PJUNC(3,44), CDCAB(22), DCAB(22), ANJUNC(44), TEST(14)
      DIMENSION ZVEL(25), VELZ(25), ECICAB(22), EXPCAB(22), ZJUNC(22)
      DIMENSION LJUNC(22), PATH(22), ICAB(22), WCAB(22), IDEV(1000)
      DIMENSION ICHECK(44)
      DIMENSION SPACEO(3,1000), PJORIG(3,44), DISPO(3)
      DIMENSION NSEW(4)
      DIMENSION UNITS(3)
      INTEGER OUTAPE,ZJUNC,ERJUNC,ANJUNC,OFLG
      INTEGER PATH
      REAL IR,IRS
      DIMENSION TEMP1(3), TEMP2(3), TEMP3(3), DISP(3), PSPACE(3)
      DIMENSION A(3), B(3), D(3), U(3), V(3), W(3), C(4), RU(3), RI(3)
      DATA NSEW/5HNORTH,5HSOUTH,5H EAST,5H WEST/
      DATA UNITS/8H (KNOTS),8H(CM/SEC),8H(FT/SEC)/
      NCJUNC=NCAB+NANC-NIR
      JUM=JUMP+1
      FACTOR=1
      PCT=PERCNTV*100.
      IF (INCPRNT.EQ.1) FACTOR=PERCNTV
      GO TO (5,10), JUM
    5 WRITE (IPRNT,465) TITLEM
      IF (IPUNCH.EQ.8H      YES) WRITE (IPNCH,470) TITLEM
      GO TO 55
   10 WRITE (IPRNT,475) TITLEM,TITLE
      WRITE (IPRNT,480) KOUNTR
      IV=IVOPT+1
      GO TO (15,20,30,40), IV
C
C     CURRENT OPTION 0
C
```

```
   15 WRITE (IPRNT,485) IVOPT                                          STR  58
      IF (IPUNCH.EQ.8H      YES) WRITE (IPNCH,490) TITLE               STR  59
      IF (IPUNCH.EQ.8H      YES) WRITE (IPNCH,495) IVOPT               STR  60
      GO TO 55                                                         STR  61
C                                                                      STR  62
C     CURRENT OPTION 1                                                 STR  63
C                                                                      STR  64
   20 WRITE (IPRNT,500) IVOPT                                          STR  65
      WRITE (IPRNT,505) UNITS(IUNIT+1)                                 STR  66
      DO 25 N=1,NVSEG                                                  STR  67
      VLFAC=VELXP(N)*FACTOR                                            STR  68
   25 WRITE (IPRNT,510) ZVEL(N),VLFAC,VELYP(N)                         STR  69
      IF (INCPRNT.EQ.1) WRITE (IPRNT,515) PCT                          STR  70
      WRITE (IPRNT,520)                                                STR  71
      THETAX=THETA                                                     STR  72
      IF (THETAX.GE.360.) THETAX=THETAX-360.                           STR  73
      THETAN=-THETA+360.+PHI                                           STR  74
      IF (THETA.EQ.360.) THETA=0.                                      STR  75
      IF (THETAN.EQ.360.) THETAN=0.                                    STR  76
      WRITE (IPRNT,525) THETA,THETAX,THETAN                            STR  77
      IF (IPUNCH.EQ.8H      YES) WRITE (IPNCH,490) TITLE               STR  78
      IF (IPUNCH.EQ.8H      YES) WRITE (IPNCH,530) THETA               STR  79
      GO TO 55                                                         STR  80
C                                                                      STR  81
C     CURRENT OPTION 2                                                 STR  82
C                                                                      STR  83
   30 WRITE (IPRNT,500) IVOPT                                          STR  84
      WRITE (IPRNT,505) UNITS(IUNIT+1)                                 STR  85
      DO 35 N=1,NVSEG                                                  STR  86
      VLFAC=VELXP(N)*FACTOR                                            STR  87
   35 WRITE (IPRNT,510) ZVEL(N),VLFAC,VELYP(N)                         STR  88
      IF (INCPRNT.EQ.1) WRITE (IPRNT,515) PCT                          STR  89
      WRITE (IPRNT,520)                                                STR  90
      IF (IPUNCH.EQ.8H      YES) WRITE (IPNCH,490) TITLE               STR  91
      IF (IPUNCH.EQ.8H      YES) WRITE (IPNCH,530) THETA               STR  92
      GO TO 55                                                         STR  93
C                                                                      STR  94
C     CURRENT OPTION 3                                                 STR  95
C                                                                      STR  96
   40 WRITE (IPRNT,500) IVOPT                                          STR  97
      DO 50 L=1,NSTA                                                   STR  98
      INS=1                                                            STR  99
      IF (XNPT(L).LT.0) INS=2                                          STR 100
      IEW=4                                                            STR 101
      IF (YWPT(L).LT.0) IEW=3                                          STR 102
      AXNPT=ABS(XNPT(L))                                               STR 103
      AYWPT=ABS(YWPT(L))                                               STR 104
      WRITE (IPRNT,535) L,AXNPT,NSEW(INS),AYWPT,NSEW(IEW),XPT(L),YPT(L) STR 105
      WRITE (IPRNT,540) UNITS(IUNIT+1)                                 STR 106
      NPS=NPPS(L)                                                      STR 107
      DO 45 LI=1,NPS                                                   STR 108
      VN=-VDIR(LI,L)+360.+PHI                                          STR 109
      VX=VDIR(LI,L)                                                    STR 110
      IF (VX.GE.360.) VX=VX-360.                                       STR 111
      VMAGP=VMAG(LI,L)/CUNITS                                          STR 112
   45 WRITE (IPRNT,510) (ZPT(LI,L),VMAGP,VN,VX)                        STR 113
   50 CONTINUE                                                         STR 114
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                 WRITE (IPRNT,545)                                          STR 115
                 IF (IPUNCH.EQ.BH     YES) WRITE (IPNCH,490) TITLE          STR 116
                 IF (IPUNCH.EQ.BH     YES) WRITE (IPNCH,495) IVOPT          STR 117
           C                                                                STR 118
           C     GENERATE ANCHOR HEADERS                                    STR 119
           C                                                                STR 120
              55 WRITE (IPRNT,550)                                          STR 121
                 WRITE (IPRNT,555)                                          STR 122
                 WRITE (IPRNT,560)                                          STR 123
                 WRITE (IPRNT,565)                                          STR 124
           C                                                                STR 125
           C     THIS SECTION CALCULATES FORCES AND ANGLES AT ANCHORS       STR 126
           C                                                                STR 127
                 DO 110 J1=1,NANC                                           STR 128
                 J3=0                                                       STR 129
                 J2=1                                                       STR 130
              60 IF (ANJUNC(J1).EQ.ZJUNC(J2)) GO TO 100                     STR 131
              65 J2=J2+1                                                    STR 132
                 IF (J2.LE.NCAB) GO TO 60                                   STR 133
                 IF (NIR.EQ.0) GO TO 110                                    STR 134
              70 J3=1                                                       STR 135
              75 IF (ANJUNC(J1).EQ.ERJUNC(J3)) GO TO 85                     STR 136
              80 J3=J3+1                                                    STR 137
                 IF (J3.LE.NIR) GO TO 75                                    STR 138
                 GO TO 110                                                  STR 139
              85 INDEX=IRJUNC(J3)                                           STR 140
                 DO 90 J4=1,NCAB                                            STR 141
                 IF (INDEX.EQ.LJUNC(J4)) GO TO 95                           STR 142
              90 CONTINUE                                                   STR 143
                 GO TO 110                                                  STR 144
              95 MM=J4                                                      STR 145
                 MX=NNODE(J4)                                               STR 146
                 T=TCAB(MX,MM)                                              STR 147
                 RX=-RCAB(1,MX,MM)                                          STR 148
                 RY=-RCAB(2,MX,MM)                                          STR 149
                 RZ=-RCAB(3,MX,MM)                                          STR 150
                 GO TO 105                                                  STR 151
             100 MM=J2                                                      STR 152
                 T=TCAB(1,MM)                                               STR 153
                 RX=RCAB(1,1,MM)                                            STR 154
                 RY=RCAB(2,1,MM)                                            STR 155
                 RZ=RCAB(3,1,MM)                                            STR 156
             105 RH=SQRT(RX**2+RY**2)                                       STR 157
                 RH2=RH                                                     STR 158
                 IF (RH2.EQ.0.) RH=1.                                       STR 159
                 A1=ASIN(RY/RH)/PIP                                         STR 160
                 IF (RH2.EQ.0.) RH=0.                                       STR 161
                 A2=ASIN(RZ/T)/PIP                                          STR 162
                 IF ((RX.LT.0.).AND.(RY.GE.0.)) A1=180.-A1                  STR 163
                 IF ((RX.LT.0.).AND.(RY.LT.0.)) A1=-180.-A1                 STR 164
                 WRITE (IPRNT,570) ANJUNC(J1),MM,T,RX,RY,RZ,RH,A1,A2        STR 165
                 IF (J2.LT.NCAB) GO TO 65                                   STR 166
                 IF ((J2.EQ.NCAB).AND.(J3.EQ.0)) GO TO 70                   STR 167
                 IF ((J2.EQ.NCAB).AND.(J3.NE.NJUNC)) GO TO 80               STR 168
             110 CONTINUE                                                   STR 169
           C                                                                STR 170
           C     GENERATE CABLE HEADERS                                     STR 171
```

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C
      WRITE (IPRNT,575)
      WRITE (IPRNT,580)
      IF (JUM.GT.1) GO TO 115
      WRITE (IPRNT,585)
      GO TO 120
  115 WRITE (IPRNT,590)
      WRITE (IPRNT,595)
  120 CONTINUE
C
C     THIS SECTION CALCULATES MAXIMUM AND MINIMUM CABLE TENSIONS
C     AND MAXIMUM CABLE DISPLACEMENTS FROM NO CURRENT LOCATION
C     BY EXTRAPOLATION BETWEEN CABLE NODES
C
C     INITIALIZE EXTREMA
C
      DO 295 NN=1,NCAB
      N=NN
      IMAX=TCAB(1,N)
      SIMAX=0.
      TMIN=TMAX
      STMIN=0.
      GO TO (135,125), JUM
  125 DMAX=0.
      DO 130 I=1,3
  130 DMAX=DMAX+(PCAB(I,1,N)-PCABO(I,1,N))**2
      DMAX=SQRT(DMAX)
      SDMAX=0.
  135 MX=NNODE(N)-1
      DO 245 MM=1,MX
      M=MM
      M1=MM+1
C
C     CALCULATE EXTRAPOLATION QUANTITIES
C
      RR=0.
      RD=0.
      DD=0.
      DO 150 I=1,3
      D(I)=(RCAB(I,M1,N)-RCAB(I,M,N))/H(N)
      GO TO (145,140), JUM
  140 A(I)=EXCAB(M,N)*RCAB(I,M,N)/TCAB(M,N)
      B(I)=(EXCAB(M1,N)*RCAB(I,M1,N)/TCAB(M1,N)-A(I))/H(N)
      U(I)=PCAB(I,M,N)-PCABO(I,M,N)
  145 RR=RR+RCAB(I,M,N)*RCAB(I,M,N)
      RD=RD+RCAB(I,M,N)*D(I)
  150 DD=DD+D(I)*D(I)
      GO TO (175,155), JUM
  155 DO 160 I=1,3
      TEMP1(I)=RCAB(I,M,N)
      TEMP2(I)=RCAB(I,M1,N)
      RCAB(I,M,N)=RCABO(I,M,N)
  160 RCAB(I,M1,N)=RCABO(I,M1,N)
      UL=0.
      UV=0.
      UVW=0.
      VW=0.
```

```
      WW=0.                                                     STR 229
      DO 165 I=1,3                                              STR 230
      V(I)=EXCAB(M,N)*RCAB(I,M,N)/TCAB(M,N)                     STR 231
      W(I)=(EXCAB(M1,N)*RCAB(I,M1,N)/TCAB(M1,N)-V(I))/H(N)      STR 232
      V(I)=A(I)-V(I)                                            STR 233
      W(I)=(B(I)-W(I))/2.                                       STR 234
      UL=UU+U(I)*L(I)                                           STR 235
      UV=UV+U(I)*V(I)                                           STR 236
      UVW=UVW+2.*U(I)*W(I)+V(I)*V(I)                            STR 237
      VW=VW+V(I)*W(I)                                           STR 238
  165 WW=WW+W(I)*W(I)                                           STR 239
      DO 170 I=1,3                                              STR 240
      RCAB(I,M,N)=TEMP1(I)                                      STR 241
  170 RCAB(I,M1,N)=TEMP2(I)                                     STR 242
  175 C(4)=0.                                                   STR 243
      C(3)=0.                                                   STR 244
      C(2)=DD                                                   STR 245
      C(1)=RD                                                   STR 246
      CALL RPOLY (C,RO,RI)                                      STR 247
C                                                               STR 248
C     CALCULATE TENSION EXTREMA IN SEGMENT                      STR 249
C                                                               STR 250
      JTIME=0                                                   STR 251
  180 CONTINUE                                                  STR 252
      DO 205 I=1,3                                              STR 253
      IF (JTIME.EQ.1) GO TO 185                                 STR 254
      IF (RI(I).NE.0.) GO TO 205                                STR 255
      IF ((RO(I).LE.0.).OR.(RO(I).GE.H(N))) GO TO 205           STR 256
      SIG=RO(I)                                                 STR 257
  185 TE=SQRT(RR+2.*RD*SIG+DD*SIG**2)                           STR 258
      IF (TE.GT.TMAX) GO TO 195                                 STR 259
      IF (TE.LT.TMIN) GO TO 200                                 STR 260
  190 IF (JTIME.EQ.0) GO TO 205                                 STR 261
      GO TO 210                                                 STR 262
  195 TMAX=TE                                                   STR 263
      STMAX=H(N)*(M-1)+SIG                                      STR 264
      GO TO 190                                                 STR 265
  200 TMIN=TE                                                   STR 266
      STMIN=H(N)*(M-1)+SIG                                      STR 267
      GO TO 190                                                 STR 268
  205 CONTINUE                                                  STR 269
      JTIME=1                                                   STR 270
      SIG=H(N)                                                  STR 271
      GO TO 180                                                 STR 272
  210 GO TO (245,215), JUM                                      STR 273
  215 C(4)=2.*WW                                                STR 274
      C(3)=3.*VW                                                STR 275
      C(2)=UVW                                                  STR 276
      C(1)=1                                                    STR 277
      CALL RPOLY (C,RO,RI)                                      STR 278
C                                                               STR 279
C     CALCULATE MAXIMUM DISPLACEMENT IN SEGMENT                 STR 280
C                                                               STR 281
      JTIME=0                                                   STR 282
  220 CONTINUE                                                  STR 283
      DO 240 I=1,3                                              STR 284
      IF (JTIME.EQ.1) GO TO 225                                 STR 285
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      IF (RI(I).NE.0.) GO TO 240                                         STR 286
      IF ((RQ(I).LE.0.).OR.(RG(I).GE.H(N))) GO TO 240                    STR 287
      SIG=RQ(I)                                                          STR 288
  225 ZARG=UU+2.*UV*SIG+UVW*SIG**2+2.*VW*SIG**3+WW*SIG**4                STR 289
C     THESE STATEMENTS CHECK ZARG FOR ZERO AND NEGATIVE VALUES           STR 290
C     ZARG SHOULD BE POSITIVE.  IF IT IS NOT IT IS COMPARED TO H(N).     STR 291
C     THE LENGTH OF ONE CABLE SEGMENT. IF IT IS SMALL BY COMPARISON, IT  STR 292
C     IS SET TO A SMALL POSITIVE VALUE                                   STR 293
      IF (ZARG.LT.0.0.AND.ABS(ZARG/H(N)).LT.0.0001) ZARG=ABS(ZARG)       STR 294
      IF (ZARG.EQ.0.0) ZARG=0.000001*H(N)                                STR 295
      DE=SQRT(ZARG)                                                      STR 296
      IF (DE.GT.DMAX) GO TO 235                                          STR 297
  230 IF (JTIME.EQ.0) GO TO 240                                          STR 298
      GO TO 245                                                          STR 299
  235 DMAX=DE                                                            STR 300
      SDMAX=H(N)*(M-1)+SIG                                               STR 301
      GO TO 230                                                          STR 302
  240 CONTINUE                                                           STR 303
      JTIME=1                                                            STR 304
      SIG=H(N)                                                           STR 305
      GO TO 220                                                          STR 306
  245 CONTINUE                                                           STR 307
C                                                                        STR 308
C     EXTHEMA ALONG A CABLE NOW DETERMINED                               STR 309
C     CALCULATE FINAL AND INITIAL COORDINATES OF MAXIMALLY DISPLACED POISTR 310
C                                                                        STR 311
      GO TO (290,250), JUM                                               STR 312
  250 RL=H(N)*MX                                                         STR 313
      IF (SDMAX.LT.RL) GO TO 260                                         STR 314
      K=LJUNC(N)                                                         STR 315
      DO 255 I=1,3                                                       STR 316
      A(I)=PJUNC(I,K)                                                    STR 317
  255 B(I)=PJUNCO(I,K)                                                   STR 318
      GO TO 285                                                          STR 319
  260 DATI(2)=TEST(4)                                                    STR 320
      DATI(3)=N                                                          STR 321
      DATI(10)=SDMAX                                                     STR 322
      J=(SDMAX/H(N))+1                                                   STR 323
      J1=J+1                                                             STR 324
      DO 265 II=1,3                                                      STR 325
      I=II                                                               STR 326
  265 A(I)=SPACE(I)                                                      STR 327
      DO 270 I=1,3                                                       STR 328
      TEMP1(I)=RCAB(I,J,N)                                               STR 329
      TEMP2(I)=RCAB(I,J1,N)                                              STR 330
      TEMP3(I)=PCAB(I,J,N)                                               STR 331
      RCAB(I,J,N)=RCABO(I,J,N)                                           STR 332
      RCAB(I,J1,N)=RCABO(I,J1,N)                                         STR 333
  270 PCAB(I,J,N)=PCABO(I,J,N)                                           STR 334
      DO 275 II=1,3                                                      STR 335
      I=II                                                               STR 336
  275 B(I)=SPACE(I)                                                      STR 337
      DO 280 I=1,3                                                       STR 338
      RCAB(I,J,N)=TEMP1(I)                                               STR 339
      RCAB(I,J1,N)=TEMP2(I)                                              STR 340
  280 PCAB(I,J,N)=TEMP3(I)                                               STR 341
  285 CONTINUE                                                           STR 342
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      WRITE (IPRNT,600) N,TMAX,STMAX,TMIN,STMIN,DMAX,SDMAX,(A(I),I=1,3),STR 343
     1(B(I),I=1,3)                                                      STR 344
      GO TO 295                                                         STR 345
  290 WRITE (IPRNT,600) N,TMAX,STMAX,TMIN,STMIN                         STR 346
  295 CONTINUE                                                          STR 347
C                                                                       STR 348
C     GENERATE JUNCTION HEADERS                                         STR 349
C                                                                       STR 350
      WRITE (IPRNT,605)                                                 STR 351
      WRITE (IPRNT,610)                                                 STR 352
      IF (JUM.GT.1) GO TO 300                                           STR 353
      WRITE (IPRNT,615)                                                 STR 354
      WRITE (IPRNT,620)                                                 STR 355
      GO TO 305                                                         STR 356
  300 CONTINUE                                                          STR 357
      WRITE (IPRNT,625)                                                 STR 358
      WRITE (IPRNT,630)                                                 STR 359
  305 CONTINUE                                                          STR 360
C                                                                       STR 361
C     THIS SECTION CALCULATES JUNCTION FORCES, LOCATIONS AND DISPLACEMENSTR 362
C                                                                       STR 363
      IF=0                                                              STR 364
      DO 395 J1=1,NGJUNC                                                STR 365
      DO 310 K=1,KARC                                                   STR 366
      IF (ANJUNC(K).EQ.J1) GO TO 395                                    STR 367
  310 CONTINUE                                                          STR 368
      GO TO (325,315), JUM                                              STR 369
  315 DO 320 J2=1,3                                                     STR 370
      DISPO(J2)=PJUNC(J2,J1)-PJORIG(J2,J1)                              STR 371
  320 DISP(J2)=PJUNC(J2,J1)-PJUNCO(J2,J1)                               STR 372
  325 J6=1                                                              STR 373
      IF (NDATC.GT.1.OR.JUM.GT.1) GO TO 335                             STR 374
      DO 330 J2=1,3                                                     STR 375
  330 PJORIG(J2,J1)=PJUNC(J2,J1)                                        STR 376
  335 CONTINUE                                                          STR 377
  340 IF (J1.EQ.ZJUNC(J6)) GO TO 360                                    STR 378
  345 IF (J1.EQ.LJUNC(J6)) GO TO 380                                    STR 379
  350 J6=J6+1                                                           STR 380
      IF (J6.LE.NCAB) GO TO 340                                         STR 381
      IF (NIR.EQ.0) GO TO 395                                           STR 382
      J7=1                                                              STR 383
  355 IF (J1.EQ.FRJUNC(J7)) GO TO 365                                   STR 384
      J7=J7+1                                                           STR 385
      IF (J7.LE.NIR) GO TO 355                                          STR 386
      GO TO 395                                                         STR 387
  360 MM=J6                                                             STR 388
      T=TCAB(1,MM)                                                      STR 389
      RX=RCAB(1,1,MM)                                                   STR 390
      RY=RCAB(2,1,MM)                                                   STR 391
      RZ=RCAB(3,1,MM)                                                   STR 392
      GO TO 390                                                         STR 393
  365 INDEX=IRJUNC(J7)                                                  STR 394
      DO 370 J8=1,NCAB                                                  STR 395
      IF (INDEX.EQ.LJUNC(J8)) GO TO 375                                 STR 396
  370 CONTINUE                                                          STR 397
  375 MM=J8                                                             STR 398
      GO TO 385                                                         STR 399
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  380 MM=J6                                                              STR 400
  385 MX=NNODE(MM)                                                       STR 401
      I=ICAB(MX,MM)                                                      STR 402
      RX=-RCAB(1,MX,MM)                                                  STR 403
      RY=-RCAB(2,MX,MM)                                                  STR 404
      RZ=-RCAB(3,MX,MM)                                                  STR 405
  390 RH=SQRT(RX**2+RY**2)                                               STR 406
      IF (RH.EQ.0.) RH=1.                                                STR 407
      A1=ASIN(RY/RH)/PIP                                                 STR 408
      A2=ASIN(RZ/T)/PIP                                                  STR 409
      IF ((RX.LT.0.).AND.(RY.GE.0.)) A1=180.-A1                          STR 410
      IF ((RX.LT.0.).AND.(RY.LT.0.)) A1=-180.-A1                         STR 411
      IF ((IF.EQ.0).AND.(JUM.EQ.1)) WRITE (IPRNT,635) J1,MM,T,A1,A2,(PJUSTR 412
     1NC(K,J1),K=1,3)                                                    STR 413
      IF ((IF.EQ.0).AND.(JUM.EQ.2)) WRITE (IPRNT,635) J1,MM,T,A1,A2,(PJUSTR 414
     1NC(K,J1),K=1,3),(DISP(I),I=1,3),(DISPO(I),I=1,3)                   STR 415
      IF (IF.EQ.1) WRITE (IPRNT,635) J1,MM,T,A1,A2                       STR 416
      IF=1                                                               STR 417
      IF ((J6.LT.NCAB).AND.(J1.EQ.ZJUNC(J6))) GO TO 345                  STR 418
      IF ((J6.LT.NCAB).AND.(J1.EQ.LJUNC(J6))) GO TO 350                  STR 419
  395 IF=0                                                               STR 420
C                                                                        STR 421
C     GENERATE INDEXED DEVICE HEADERS                                    STR 422
C                                                                        STR 423
      WRITE (IPRNT,640)                                                  STR 424
      WRITE (IPRNT,645)                                                  STR 425
      IF (JUM.GT.1) GO TO 400                                            STR 426
      WRITE (IPRNT,650)                                                  STR 427
      WRITE (IPRNT,655)                                                  STR 428
      GO TO 405                                                          STR 429
  400 WRITE (IPRNT,660)                                                  STR 430
      WRITE (IPRNT,665)                                                  STR 431
  405 CONTINUE                                                           STR 432
C                                                                        STR 433
C     THIS SECTION CALCULATES TENSIONS AT INDEXED DEVICES,               STR 434
C     DEVICE LOCATIONS, AND DEVICE DISPLACEMENTS                         STR 435
C                                                                        STR 436
      IF (NDEV.EQ.0) GO TO 460                                           STR 437
      IF (IPUNCH.NE.8H      YES) GO TO 420                               STR 438
      IF (NDATC.GT.1) GO TO 415                                          STR 439
      NCPUDEV=0                                                          STR 440
      DO 410 N=1,NDEV                                                    STR 441
      READ (INTAPE,675) (DATI(I),I=1,10)                                 STR 442
      IF ((DATI(2).NE.TEST(3)).AND.(DATI(6).EQ.DEVWT).AND.(NDATC.EQ.1))  STR 443
     1NCPUDEV=NCPUDEV+1                                                  STR 444
  410 CONTINUE                                                           STR 445
      REWIND INTAPE                                                      STR 446
  415 WRITE (IPNCH,670) NCPUDEV                                          STR 447
  420 DO 455 N=1,NDEV                                                    STR 448
      READ (INTAPE,675) (DATI(I),I=1,10)                                 STR 449
      INDEX=N                                                            STR 450
C 501 FORMAT (I4,A4,8E15.8)                                              STR 451
      IF (DATI(2).EQ.TEST(3)) GO TO 455                                  STR 452
      K=DATI(3)                                                          STR 453
      M=DATI(1)/H(K)+1                                                   STR 454
      SIGMA=DATI(10)-(M-1)*H(K)                                          STR 455
      TEN2=0.                                                            STR 456
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      DO 425 II=1,3                                                     STR 457
      I=II                                                              STR 458
      PSPACE(I)=SPACE(I)                                                STR 459
      IF (NDATC.EQ.1.AND.JUM.EQ.1) SPACEO(I,INDEX)=SPACE(I)             STR 460
  425 TEN2=TEN2+(RCAB(I,M,K)+(RCAB(I,M+1,K)-RCAB(I,M,K))*SIGMA/H(K))**2 STR 461
      TEN=SQRT(TEN2)                                                    STR 462
      GO TO (430,435), JUM                                              STR 463
  430 IF ((IPUNCH.EQ.8H     YES).AND.(DATI(6).EQ.DEVWT)) WRITE (IPNCH,68STR 464
     10) INDEX,K,DATI(10),(PSPACE(I),I=1,3)                             STR 465
      IF (DATI(5).EQ.0) WRITE (IPRNT,685) INDEX,K,DATI(10),TEN,(PSPACE(ISTR 466
     1),I=1,3),DATI(6),DATI(9),DATI(7),TDOCAB(INDEX)                    STR 467
      GO TO 455                                                         STR 468
  435 DO 440 I=1,3                                                      STR 469
      TEMP1(I)=RCAB(I,M,K)                                              STR 470
      TEMP2(I)=RCAB(I,M+1,K)                                            STR 471
      TEMP3(I)=PCAB(I,M,K)                                              STR 472
      RCAB(I,M,K)=RCABO(I,M,K)                                          STR 473
      RCAB(I,M+1,K)=RCABO(I,M+1,K)                                      STR 474
  440 PCAB(I,M,K)=PCABO(I,M,K)                                          STR 475
      DO 445 II=1,3                                                     STR 476
      I=II                                                              STR 477
      DISPO(I)=PSPACE(I)-SPACEO(I,INDEX)                                STR 478
  445 DISP(I)=PSPACE(I)-SPACE(I)                                        STR 479
      DO 450 I=1,3                                                      STR 480
      RCAB(I,M,K)=TEMP1(I)                                              STR 481
      RCAB(I,M+1,K)=TEMP2(I)                                            STR 482
  450 PCAB(I,M,K)=TEMP3(I)                                              STR 483
      IF ((IPUNCH.EQ.8H     YES).AND.(DATI(6).EQ.DEVWT)) WRITE (IPNCH,68STR 484
     10) INDEX,K,DATI(10),(PSPACE(I),I=1,3)                             STR 485
      IF (DATI(5).NE.0.) GO TO 455                                      STR 486
      WRITE (IPRNT,690) INDEX,K,DATI(10),TEN,(PSPACE(I),I=1,3),(DISP(I),STR 487
     1I=1,3),(DISPO(I),I=1,3)                                           STR 488
  455 CONTINUE                                                          STR 489
  460 REWIND INTAPE                                                     STR 490
      RETURN                                                            STR 491
C                                                                       STR 492
  465 FORMAT (1H1,8A10//,34H ARRAY EQUILIBRIUM WITH NO CURRENT//)       STR 493
  470 FORMAT (8A10/35H ARRAY EQUILIBRIUM WITH NO CURRENT )              STR 494
  475 FORMAT (1H1,8A10//1X,8A10//)                                      STR 495
  480 FORMAT (/1X,39HNUMBER OF ITERATIONS FOR CONVERGENCE - ,I5/)       STR 496
  485 FORMAT (38H ARRAY EQUILIBRIUM WITH CURRENT OPTION,I3//)           STR 497
  490 FORMAT (8A10)                                                     STR 498
  495 FORMAT (38H ARRAY EQUILIBRIUM WITH CURRENT OPTION,I3)             STR 499
  500 FORMAT (25H CURRENT FIELD OPTION IS ,I1)                          STR 500
  505 FORMAT (/7X,12HZ-COORDINATE,6X,12HMAGNITUDE OF,7X,12HDIRECTION OF/STR 501
     1,8X,10HOF CURRENT,7X,12HCURRENT AT Z,7X,12HCURRENT AT Z/44X,11HFROSTR 502
     2M N-AXIS,/10X,6H(FEET),11X,A8,10X,9H(DEGREES))                    STR 503
  510 FORMAT (7X,F10.2,10X,F8.3,10X,F8.3,11X,F8.3)                      STR 504
  515 FORMAT (/F10.1,24H PERCENT OF FULL CURRENT)                       STR 505
  520 FORMAT (//1X,78H*****CURRENT DIRECTION IS POSITIVE IN THE CLOCKWISSTR 506
     1E SENSE FROM THE N-AXIS*****//)                                   STR 507
  525 FORMAT (24H ARRAY EQUILIBRIUM WITH ,F8.2,15H DEGREE CURRENT,//1X,4STR 508
     10HARRAY EQUILIBRIUM WITH CURRENT DIRECTION,/F10.2,2X,42HDEGREES FRSTR 509
     2OM X-AXIS(+ IS COUNTERCLOCKWISE)/F10.2,2X,35HDEGREES FROM N-AXIS(+STR 510
     3IS CLOCKWISE)//)                                                  STR 511
  530 FORMAT (24H ARRAY EQUILIBRIUM WITH ,F8.2,15H DEGREE CURRENT)      STR 512
  535 FORMAT (//1X,26HLOCATION OF STRING NUMBER-,I1/1X,F8.0,1X,4HFEET,1XSTR 513
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```
     1,A5,2X,2HBY,2X,F8.0,1X,4HFEET,1X,A5,10X,2HOR,10X,2HX=,F8.0,4HFEET,STR 514
     25X,2HY=,F8.0,4HFEET)                                            STR 515
 540 FORMAT (/44X,12HDIRECTION OF,7X,12HDIRECTION OF/7X,12HZ-COORDINATESTR 516
     1,6X,12HMAGNITUDE OF,7X,12HCURRENT AT Z,7X,12HCURRENT AT Z/8X,10HOFSTR 517
     2 CURRENT,8X,10HOF CURRENT,7X,13HN-AXIS SYSTEM,6X,13HX-AXIS SYSTEM/STR 518
     310X,6H(FEET),11X,AB,10X,9H(DEGREES),10X,9H(DEGREES))            STR 519
 545 FORMAT (//1X,78H*****CURRENT DIRECTION IS POSITIVE IN THE CLOCKWISSTR 520
     1E SENSE FROM THE N-AXIS*****/1X,85H*****CURRENT DIRECTION IS POSITSTR 521
     2IVE IN THE COUNTERCLOCKWISE SENSE FROM THE X-AXIS*****//)        STR 522
 550 FORMAT (1H ,13HARRAY ANCHORS)                                    STR 523
 555 FORMAT (1H ,13H----- -------/)                                   STR 524
 560 FORMAT (1H ,32HJUNC. NO.  CABLE AT   TENSION AT,14X,26HFORCE COMPOSTR 525
     1NENTS AT ANCHOR,13X,16HCABLE ANGLES WRT)                         STR 526
 565 FORMAT (1H ,30HOF ANCHOR   ANCHOR        ANCHOR8X,6HX-COMP,6X,6HY-COSTR 527
     1MP,6X,6HZ-COMP,3X,9HHOR.-COMP,5X,16HX-AXIS  XY-PLANE)           STR 528
 570 FORMAT (1H ,3X,I2,9X,I2,5X,F10.2,3X,4(F10.2,2X),2(2X,F7.2,1X))   STR 529
 575 FORMAT (1H ,///1H ,12HARRAY CABLES)                               STR 530
 580 FORMAT (1H ,12H----- ------/)                                    STR 531
 585 FORMAT (1H ,41HCABLE  MAXIMUM  S-COORD  MINIMUM  S-COORD/1X,38H NOSTR 532
     1.   TENSION     OF      TENSION     OF)                          STR 533
 590 FORMAT (1H ,120HCABLE  MAXIMUM  S-COORD  MINIMUM  S-COORD  MAXIMUMSTR 534
     1  S-COORD      LOCATION OF THIS POINT     NO CURRENT LOC. OF THIS PSTR 535
     2OINT)                                                           STR 536
 595 FORMAT (1H ,120H NO.   TENSION     OF      TENSION     OF      DISP. STR 537
     1    OF       X-COORD   Y-COORD   Z-COORD   X-COORD   Y-COORD   Z-COSTR 538
     2ORD )                                                           STR 539
 600 FORMAT (1H ,I4,1X,6F9.2,6F10.2)                                  STR 540
 605 FORMAT (1H ///1H ,15HARRAY JUNCTIONS)                             STR 541
 610 FORMAT (1H ,15H----- ---------/)                                 STR 542
 615 FORMAT (1H ,27HJUNC.  CABLE AT   TENSION AT,3X,16HCABLE ANGLES WRT,STR 543
     16X,17HJUNCTION LOCATION)                                         STR 544
 620 FORMAT (1H ,15H NO.    JUNCTION3X,8HJUNCTION4X,16HX-AXIS  XY-PLANE,STR 545
     12X,25HX-COORD   Y-COORD   Z-COORD)                               STR 546
 625 FORMAT (1H ,27HJUNC.  CABLE AT   TENSION AT,3X,16HCABLE ANGLES WRT,STR 547
     16X,17HJUNCTION LOCATION,9X,21HDISP  FROM NO CURRENT,4X,25HDISP FROSTR 548
     2M ORIG NO CURRENT)                                               STR 549
 630 FORMAT (1H ,15H NO.    JUNCTION3X,8HJUNCTION4X,16HX-AXIS  XY-PLANE,STR 550
     12X,25HX-COORD   Y-COORD   Z-COORD,3X,24HX-DISP   Y-DISP   Z-DISP,3X,STR 551
     224HX-DISP   Y-DISP   Z-DISP)                                     STR 552
 635 FORMAT (1H ,I4,6X,I2,4X,F10.2,2(3X,F7.2),9F9.2)                  STR 553
 640 FORMAT (1H ,///1H ,34HINDEXED DEVICES ALONG ARRAY CABLES)         STR 554
 645 FORMAT (1H ,34H------- ------- ----- ----- ------/)               STR 555
 650 FORMAT (1H ,7HDEVICE ,5HCABLE,6X,1HS,7X,10HTENSION AT,8X,15HDEVICESTR 556
     1 LOCATION,13X,6HDEVICE,4X,6HDEVICE,4X,6HNORMAL,6X,4HTANG)        STR 557
 655 FORMAT (1H ,34HINDEX   NO.   COORDINATE     DEVICE,5X,25HX-COORD  YSTR 558
     1-COORD  Z-COORD,8X,6HWEIGHT,4X,6HLENGTH,3X,7HDRAG CO,3X,7HDRAG CO)STR 559
 660 FORMAT (1H ,7HDEVICE ,5HCABLE,6X,1HS,7X,10HTENSION AT,10X,15HDEVICSTR 560
     1E LOCATION,12X,21HDISP  FROM NO CURRENT,8X,25HDISP FROM ORIG NO CUSTR 561
     2RRENT)                                                          STR 562
 665 FORMAT (1H ,34HINDEX   NO.   COORDINATE     DEVICE,7X,25HX-COORD  YSTR 563
     1-COORD  Z-COORD,6X,24HX-DISP   Y-DISP   Z-DISP,6X,24HX-DISP   Y-DISTR 564
     2SP   Z-DISP)                                                     STR 565
 670 FORMAT (I10)                                                     STR 566
 675 FORMAT (F4.0,A4,8E15.8)                                          STR 567
 680 FORMAT (2I10,4E15.6)                                             STR 568
 685 FORMAT (1H ,I4,4X,I2,4X,F9.2,4X,F9.2,1X,3F9.2,4X,2F10.2,2F10.3)  STR 569
 690 FORMAT (1H ,I4,4X,I2,4X,F9.2,3X,F9.2,1X,3(3X,3F9.2))             STR 570
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                    END                                              STR 571-
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CARD NR.	SEVERITY	DETAILS	DIAGNOSIS OF PROBLEM
47	I		AN IF STATEMENT MAY BE MORE EFFICIENT THAN A 2 OR 3 BRANCH COMPUTED GO TO STATEMENT.
194	I		AN IF STATEMENT MAY BE MORE EFFICIENT THAN A 2 OR 3 BRANCH COMPUTED GO TO STATEMENT.
212	I		AN IF STATEMENT MAY BE MORE EFFICIENT THAN A 2 OR 3 BRANCH COMPUTED GO TO STATEMENT.
219	I		AN IF STATEMENT MAY BE MORE EFFICIENT THAN A 2 OR 3 BRANCH COMPUTED GO TO STATEMENT.
27[illegible]	I		AN IF STATEMENT MAY BE MORE EFFICIENT THAN A 2 OR 3 BRANCH COMPUTED GO TO STATEMENT.
312	I		AN IF STATEMENT MAY BE MORE EFFICIENT THAN A 2 OR 3 BRANCH COMPUTED GO TO STATEMENT.
369	I		AN IF STATEMENT MAY BE MORE EFFICIENT THAN A 2 OR 3 BRANCH COMPUTED GO TO STATEMENT.
463	I		AN IF STATEMENT MAY BE MORE EFFICIENT THAN A 2 OR 3 BRANCH COMPUTED GO TO STATEMENT.

```
      *DECK SWTCH                                                         SWT    1
            SUBROUTINE SWTCH                                              SWT    2
      C                                                                   SWT    3
      C     THIS ROUTINE SWITCHES INPUT DATA                              SWT    4
      C                                                                   SWT    5
            COMMON /B3/ VELX(25),VELY(25)                                 SWT    6
            COMMON /B1/ FEJUNC,IR,DELTAI,DELTA,IRS,TFJUNC,E,ES,FCAB,RCAB,JUMP,SWT    7
           1PJUNCS,PCAB,PCABE,PCABO,RCABO,THETA,PJUNCO                    SWT    8
            COMMON /B2/ NCAB,NNODE,ERJUNC,IRJUNC,DATI,DATN,H,PJUNC,CDCAB,DCAB,SWT    9
           1FATE,NANG,ANJUNC,IHEAD,IPRNT,INTAPE,OUTAPE,ITIME,IFLG,OFLG,NIR,THESWT   10
           2TAS,THETAE,COMPD,THETAB,NJUNC,RHO,TEST,NVSEG,ZVEL,VELZ,PIP,ECICAB,SWT   11
           3EXPCAB,ZJUNC,LJUNC,PATH,ICAB,IVOPT,WCAB,IDEV,ICHECK,NDEV,NDATC  SWT   12
            DIMENSION FEJUNC(3,44), IR(3,44), IRS(3,44), TFJUNC(3,44), PJUNCO(SWT   13
           13,44)                                                         SWT   14
            DIMENSION FCAB(3,51,22), RCAB(3,51,22), PJUNCS(3,44), PCAB(3,51,22SWT   15
           1)                                                             SWT   16
            DIMENSION PCABE(3,51,22), PCABO(3,51,22), RCABO(3,51,22)      SWT   17
            DIMENSION NNODE(22), ERJUNC(44), IRJUNC(44), DATI(10), DATN(10), HSWT   18
           1(22)                                                          SWT   19
            DIMENSION PJUNC(3,44), CDCAB(22), DCAB(22), ANJUNC(44), TEST(14)  SWT   20
            DIMENSION ZVEL(25), VELZ(25), ECICAB(22), EXPCAB(22), ZJUNC(22)   SWT   21
            DIMENSION LJUNC(22), PATH(22), ICAB(22), WCAB(22), IDEV(1000)    SWT   22
            DIMENSION ICHECK(44)                                          SWT   23
            INTEGER OUTAPE,ZJUNC,ERJUNC,ANJUNC,OFLG                       SWT   24
            INTEGER PATH                                                  SWT   25
            REAL IR,IRS                                                   SWT   26
            DO 5 I=1,10                                                   SWT   27
          5 DATI(I)=DATN(I)                                               SWT   28
            RETURN                                                        SWT   29
            END                                                           SWT   30-
```

```
      *DECK TANG                                                        TAN    1
            FUNCTION TANG (I)                                           TAN    2
      C                                                                 TAN    3
      C     THIS ROUTINE CALCULATES THE UNIT TANGENT TO A CABLE AT ANY POINT TAN    4
      C                                                                 TAN    5
            COMMON /B3/ VELX(25),VELY(25)                               TAN    6
            COMMON /B1/ FEJUNC,IR,DELTAI,DELTA,IRS,TFJUNC,E,ES,FCAB,RCAB,JUMP,TAN    7
           1PJUNCS,PCAB,PCABE,PCABO,RCABO,THETA,PJUNCO                  TAN    8
            COMMON /B2/ NCAB,NNODE,ERJUNC,IRJUNC,DATI,DATN,H,PJUNC,CDCAB,DCAB,TAN    9
           1FATE,NANC,ANJUNC,IREAD,IPRNT,INTAPE,OUTAPE,ITIME,IFLG,OFLG,NIR,THETAN   10
           2TAS,THETAE,COMPD,THETAB,NJUNC,RHO,TEST,NVSEG,ZVEL,VELZ,PIP,ECICAB,TAN   11
           3EXPCAB,ZJUNC,LJUNC,PATH,ICAB,IVOPT,WCAB,IDEV,ICHECK,NDEV,NDATC   TAN   12
            DIMENSION FEJUNC(3,44), IR(3,44), IRS(3,44), TFJUNC(3,44), PJUNCO(TAN   13
           13,44)                                                       TAN   14
            DIMENSION FCAB(3,51,22), RCAB(3,51,22), PJUNCS(3,44), PCAB(3,51,22TAN   15
           1)                                                           TAN   16
            DIMENSION PCABE(3,51,22), PCABO(3,51,22), RCABO(3,51,22)    TAN   17
            DIMENSION NNODE(22), ERJUNC(44), IRJUNC(44), DATI(10), DATN(10), HTAN   18
           1(22)                                                        TAN   19
            DIMENSION PJUNC(3,44), CDCAB(22), DCAB(22), ANJUNC(44), TEST(14) TAN   20
            DIMENSION ZVEL(25), VELZ(25), ECICAB(22), EXPCAB(22), ZJUNC(22)  TAN   21
            DIMENSION LJUNC(22), PATH(22), ICAB(22), WCAB(22), IDEV(1000)    TAN   22
            DIMENSION ICHECK(44)                                        TAN   23
            INTEGER OUTAPE,ZJUNC,ERJUNC,ANJUNC,OFLG                     TAN   24
            INTEGER PATH                                                TAN   25
            REAL IR,IRS                                                 TAN   26
            N=DATI(3)                                                   TAN   27
            M=(DATI(10)/H(N))+1                                         TAN   28
      C                                                                 TAN   29
      C     CALCULATE DISTANCE, SIGMA, OF POINT FROM NODE M             TAN   30
      C                                                                 TAN   31
            SIGMA=DATI(10)-(M-1)*H(N)                                   TAN   32
      C                                                                 TAN   33
      C     CALCULATE EXTRAPOLATION QUANTITIES                          TAN   34
      C                                                                 TAN   35
            EM=RCAB(I,M,N)/TCAB(M,N)                                    TAN   36
            EM1=RCAB(I,M+1,N)/TCAB(M+1,N)                               TAN   37
      C                                                                 TAN   38
      C     CALCULATE TANGENT                                           TAN   39
      C                                                                 TAN   40
            TANG=EM+((EM1-EM)/H(N))*SIGMA                               TAN   41
            RETURN                                                      TAN   42
            END                                                         TAN   43-
```

```
*DECK TAPOUT
      SUBROUTINE TAPOUT
C
C     THIS ROUTINE GENERATES THE TAPE OR CARDS GIVING
C     THE LOCATIONS OF THE INDEXED DEVICES
C
      COMMON /B3/ VELX(25),VELY(25)
      COMMON /B1/ FEJUNC,IR,DELTAI,DELTA,IRS,TFJUNC,E,ES,FCAB,RCAB,JUMP,
     1PJUNCS,PCAB,PCABE,PCABO,RCABO,THETA,PJUNCO
      COMMON /B2/ NCAB,NNODE,ERJUNC,IRJUNC,DATI,DATN,H,PJUNC,CDCAB,DCAB,
     1FATE,NANC,ANJUNC,IREAD,IPRNT,INTAPE,OUTAPE,ITIME,IFLG,OFLG,NIR,THE
     2TAS,THETAE,COMPD,THETAB,NJUNC,RHO,TEST,NVSEG,ZVEL,VELZ,PIP,ECICAB,
     3EXPCAB,ZJUNC,LJUNC,PATH,ICAB,IVOPT,WCAB,IDEV,ICHECK,NDEV,NDATC
      DIMENSION FEJUNC(3,44), IR(3,44), IRS(3,44), TFJUNC(3,44), PJUNCO(
     13,44)
      DIMENSION FCAB(3,51,22), RCAB(3,51,22), PJUNCS(3,44), PCAB(3,51,22
     1)
      DIMENSION PCABE(3,51,22), PCABO(3,51,22), RCABO(3,51,22)
      DIMENSION NNODE(22), ERJUNC(44), IRJUNC(44), DATI(10), DATN(10), H
     1(22)
      DIMENSION PJUNC(3,44), CDCAB(22), DCAB(22), ANJUNC(44), TEST(14)
      DIMENSION ZVEL(25), VELZ(25), ECICAB(22), EXPCAB(22), ZJUNC(22)
      DIMENSION LJUNC(22), PATH(22), ICAB(22), WCAB(22), IDEV(1000)
      DIMENSION ICHECK(44)
      DIMENSION PSPACE(3)
      INTEGER OUTAPE,ZJUNC,ERJUNC,ANJUNC,OFLG
      INTEGER PATH
      REAL IR,IRS
      ID1=4H CUR
      ID2=4H DEV
      ID3=4H REC
      JUM=JUMP+1
      GO TO (5,10), JUM
    5 WRITE (OUTAPE,35) ID3,NDATC
      WRITE (OUTAPE,35) ID1,JUMP
      GO TO 15
   10 WRITE (OUTAPE,35) ID1,JUMP,THETA
   15 IF (NDEV.EQ.0) GO TO 30
      DO 25 NN=1,NDEV
      READ (INTAPE,40) (DATI(K),K=1,10)
      INDEX=DATI(5)
C
C     CALCULATE LOCATION OF DEVICE IN SPACE
C
      DO 20 J=1,3
      I=J
   20 PSPACE(I)=SPACE(I)
      WRITE (OUTAPE,35) ID2,INDEX,(PSPACE(I),I=1,3)
   25 CONTINUE
   30 CONTINUE
      REWIND INTAPE
      RETURN
C
   35 FORMAT (A4,I4,3F10.2)
   40 FORMAT (F4.0,A4,8E15.8)
      END
```

CARD NR.	SEVERITY	DETAILS	DIAGNOSIS OF PROBLEM
33	I		AN IF STATEMENT MAY BE MORE EFFICIENT THAN A 2 OR 3 BRANCH COMPUTED GO TO STATEMENT.

```
      *DECK TCAB                                                        TCA   1
            FUNCTION TCAB (M,K)                                         TCA   2
      C                                                                 TCA   3
      C     THIS ROUTINE CALCULATES THE TENSION AT NODE M OF CABLE K    TCA   4
      C                                                                 TCA   5
            COMMON /B3/ VELX(25),VELY(25)                               TCA   6
            COMMON /B1/ FEJUNC,IR,DELTA1,DELTA,IRS,TFJUNC,E,ES,FCAB,RCAB,JUMP,TCA   7
           1PJUNCS,PCAB,PCABE,PCABO,RCABO,THETA,PJUNCO                  TCA   8
            COMMON /B2/ NCAB,NNODE,ERJUNC,IRJUNC,DATI,DATN,H,PJUNC,CDCAB,DCAB,TCA   9
           1FATE,NANG,ANJUNC,IREAD,IPRNT,INTAPE,OUTAPE,ITIME,IFLG,OFLG,NIR,THETCA  10
           2TAS,THETAL,CONPD,THETAB,NJUNC,RHO,TEST,NVSEG,ZVEL,VELZ,PIP,ECICAB,TCA  11
           3EXPCAB,ZJUNC,LJUNC,PATH,ICAB,IVOPT,WCAB,IDEV,ICHECK,NDEV    TCA  12
            DIMENSION FEJUNC(3,44), IR(3,44), IRS(3,44), TFJUNC(3,44), PJUNCO(TCA  13
           13,44)                                                       TCA  14
            DIMENSION FCAB(3,51,22), RCAB(3,51,22), PJUNCS(3,44), PCAB(3,51,22TCA  15
           1)                                                           TCA  16
            DIMENSION PCABE(3,51,22), PCABO(3,51,22), RCABO(3,51,22)    TCA  17
            DIMENSION NNODE(22), ERJUNC(44), IRJUNC(44), DATI(10), DATN(10), HTCA  18
           1(22)                                                        TCA  19
            DIMENSION PJUNC(3,44), CDCAB(22), DCAB(22), ANJUNC(44), TEST(14)  TCA  20
            DIMENSION ZVEL(25), VELZ(25), ECICAB(22), EXPCAB(22), ZJUNC(22)   TCA  21
            DIMENSION LJUNC(22), PATH(22), ICAB(22), WCAB(22), IDEV(1000)     TCA  22
            DIMENSION ICHECK(44)                                        TCA  23
            INTEGER OUTAPE,ZJUNC,ERJUNC,ANJUNC,OFLG                     TCA  24
            INTEGER PATH                                                TCA  25
            REAL IR,IRS                                                 TCA  26
            TCAB=SQRT(RCAB(1,M,K)**2+RCAB(2,M,K)**2+RCAB(3,M,K)**2)     TCA  27
            RETURN                                                      TCA  28
            END                                                         TCA  29-
```

```
*DECK VELOC                                                             VEL   1
      FUNCTION VELOC (I,PSPACE)                                         VEL   2
C                                                                       VEL   3
C     THIS ROUTINE SPECIFIES THE I COMPONENT OF THE CURRENT FIELD       VEL   4
C     AT AN ARBITRARY POINT IN SPACE, PSPACE(I)                         VEL   5
C                                                                       VEL   6
      COMMON /B3/ VELX(25),VELY(25)                                     VEL   7
      COMMON /B1/ FEJUNC,IR,DELTAI,DELTA,IRS,TFJUNC,E,ES,FCAB,RCAB,JUMP,VEL   8
     1PJUNCS,PCAB,PCABE,PCABO,RCABO,THETA,PJUNCO                       VEL   9
      COMMON /B2/ NCAB,NNODE,ERJUNC,IRJUNC,DATI,DATN,H,PJUNC,CDCAB,DCAB,VEL  10
     1FATE,NANC,ANJUNC,IREAD,IPRNT,INTAPE,OUTAPE,ITIME,IFLG,OFLG,NIR,THEVEL  11
     2IAS,THETAE,COMPD,THETAB,NJUNC,RHO,TEST,NVSEG,ZVEL,VELZ,PIP,ECICAB,VEL  12
     3EXPCAB,ZJUNC,LJUNC,PATH,ICAB,IVOPT,WCAB,IDEV,ICHECK,NDEV,NDATC    VEL  13
      COMMON /PIBLK/ PI                                                 VEL  14
      COMMON /KITER/ KOUNTR,NIT,MXITER,NSTEPS,ISTEP,PERCNTV,INCPRNT     VEL  15
      DIMENSION FEJUNC(3,44), IR(3,44), IRS(3,44), TFJUNC(3,44), PJUNCO(VEL  16
     13,44)                                                             VEL  17
      DIMENSION FCAB(3,51,22), RCAB(3,51,22), PJUNCS(3,44), PCAB(3,51,22VEL  18
     1)                                                                 VEL  19
      DIMENSION PCABE(3,51,22), PCABO(3,51,22), RCABO(3,51,22)          VEL  20
      DIMENSION NNODE(22), ERJUNC(44), IRJUNC(44), DATI(10), DATN(10), HVEL  21
     1(22)                                                              VEL  22
      DIMENSION PJUNC(3,44), CDCAB(22), DCAB(22), ANJUNC(44), TEST(14)  VEL  23
      DIMENSION ZVEL(25), VELZ(25), ECICAB(22), EXPCAB(22), ZJUNC(22)   VEL  24
      DIMENSION LJUNC(22), PATH(22), ICAB(22), WCAB(22), IDEV(1000)     VEL  25
      DIMENSION ICHECK(44)                                              VEL  26
      DIMENSION PSPACE(3)                                               VEL  27
      INTEGER OUTAPE,ZJUNC,ERJUNC,ANJUNC,OFLG                           VEL  28
      INTEGER PATH                                                      VEL  29
      REAL IR,IRS                                                       VEL  30
      DTR=PI/180.                                                       VEL  31
      PERCNTV=FLOAT(ISTEP)/FLOAT(NSTEPS)                                VEL  32
      T=THETA*DTR                                                       VEL  33
      GO TO (5,5,40), I                                                 VEL  34
    5 Z=PSPACE(3)                                                       VEL  35
      DO 10 KK=1,NVSEG                                                  VEL  36
      K=KK                                                              VEL  37
      IF (Z.GT.ZVEL(K)) GO TO 10                                        VEL  38
      GO TO 15                                                          VEL  39
   10 CONTINUE                                                          VEL  40
      VFPSX=1.6878*VELX(K)                                              VEL  41
      VFPSY=1.6878*VELY(K)                                              VEL  42
      GO TO 25                                                          VEL  43
   15 IF (K.NE.1) GO TO 20                                              VEL  44
      VFPSX=1.6878*VELX(K)                                              VEL  45
      VFPSY=1.6878*VELY(K)                                              VEL  46
      GO TO 25                                                          VEL  47
   20 SIGMA=Z-ZVEL(K-1)                                                 VEL  48
      SLOPX=(VELX(K)-VELX(K-1))/(ZVEL(K)-ZVEL(K-1))                     VEL  49
      SLOPY=(VELY(K)-VELY(K-1))/(ZVEL(K)-ZVEL(K-1))                     VEL  50
      VFPSY=1.6878*(VELY(K-1)+SLOPY*SIGMA)                              VEL  51
      VFPSX=1.6878*(VELX(K-1)+SLOPX*SIGMA)                              VEL  52
   25 VMG=SQRT(VFPSX**2+VFPSY**2)                                       VEL  53
      IF (VFPSX.EQ.0.0) VFPSX=0.000001                                  VEL  54
      A=ATAN2(VFPSY,VFPSX)+T                                            VEL  55
      GO TO (30,35), I                                                  VEL  56
   30 VFLOC=VMG*COS(A)*PERCNTV                                          VEL  57
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```
   30 VELOC=VPG*COS(A)*PERCNTV                                           VEL  57

FUNCTION VELOC       74/74    OPT=1                  FTN 4.6+433E       03/07/80  11.41.06       PAGE     2

                RETURN                                                   VEL  58
             35 VELOC=VPG*SIN(A)*PERCNTV                                 VEL  59
    60          RETURN                                                   VEL  60
             40 VELOC=0.                                                 VEL  61
                RETURN                                                   VEL  62
                END                                                      VEL  63-
```

CARD NR.	SEVERITY	DETAILS	DIAGNOSIS OF PROBLEM
34	I		AN IF STATEMENT MAY BE MORE EFFICIENT THAN A 2 OR 3 BRANCH COMPUTED GO TO STATEMENT.
56	I		AN IF STATEMENT MAY BE MORE EFFICIENT THAN A 2 OR 3 BRANCH COMPUTED GO TO STATEMENT.

```
*DECK REDVEL
      SUBROUTINE REDVEL (IR,IW)
C
C     ROUTINE TO READ CURRENT DATA FOR CURRENT OPTION 3
C
      COMMON /BIN/ ISCR
      COMMON /CVEL/ VMAG(25,4),VDIR(25,4),ZPT(25,4),XPT(4),YPT(4),NPPS(4
     1),NSTA
      COMMON /PCUR/ XNPT(4),YWPT(4)
      COMMON /TITL/ TITLE(8),PHI,CUNITS,IUNIT,VELXP(25),VELYP(25)
      COMMON /B2/ NCAB,NNODE,ERJUNC,IRJUNC,DATI,DATN,H,PJUNC,CDCAB,DCAB,
     1FATE,NANC,ANJUNC,IREAD,IPRNT
      COMMON /PIBLK/ PI
      DIMENSION NS(4)
      DIMENSION STORE(8)
      DIMENSION NNODE(22), ERJUNC(44), IRJUNC(44), DATI(10), DATN(10), H
     1(22)
      DIMENSION PJUNC(3,44), CDCAB(22), DCAB(22), ANJUNC(44)
      IBAD=0
      IFORM=1
      DIR=PI/180.
      DO 20 J=1,NSTA
      READ (IR,30) STORE
      WRITE (ISCR) IFORM,IBAD
      WRITE (ISCR,30) STORE
      DECODE (30,35,STORE) NS(J),NPPS(J),XNPT(J),YWPT(J)
      IF (XNPT(J).NE.0..OR.YWPT(J).NE.0.) GO TO 5
      XPT(J)=0.
      YPT(J)=0.
      GO TO 10
    5 W=SQRT(XNPT(J)**2+YWPT(J)**2)
      A=ATAN2(YWPT(J),XNPT(J))
      B=A+PHI*DIR
      XPT(J)=W*COS(B)
      YPT(J)=W*SIN(B)
   10 NP=NPPS(J)
      DO 15 I=1,NP
      READ (IR,30) STORE
      WRITE (ISCR) IFORM,IBAD
      WRITE (ISCR,30) STORE
      DECODE (40,40,STORE) NS(J),ZPT(I,J),VMAG(I,J),VDIR(I,J)
   15 VMAG(I,J)=VMAG(I,J)*CUNITS
   20 CONTINUE
      DO 25 J=1,NSTA
      NP=NPPS(J)
      DO 25 I=1,NP
   25 VDIR(I,J)=360.+PHI-VDIR(I,J)
      RETURN
C
   30 FORMAT (8A10)
   35 FORMAT (2I5,2F10.0)
   40 FORMAT (I5,5X,3F10.0)
      END
```

```
      *DECK INTVEL                                                      INT   1
            SUBROUTINE INTVEL (WW,PSPACE)                               INT   2
            COMMON /CVEL/ VMAG(25,4),VDIR(25,4),ZPT(25,4),XPT(4),YPT(4),NPPS(4INT   3
          1),NSTA                                                       INT   4
            COMMON /CLET/ X,Y,DUMMY(9),VDR(4),VMG(4)                    INT   5
            COMMON /PIBLK/ PI                                           INT   6
            DIMENSION WW(3), PSPACE(3)                                  INT   7
            DIMENSION V1(4), V2(4)                                      INT   8
            STAT(Y1,Y2)=Y1+(Y2-Y1)*R                                    INT   9
            X=PSPACE(1)                                                 INT  10
            Y=PSPACE(2)                                                 INT  11
            Z=PSPACE(3)                                                 INT  12
            DO 20 J=1,NSTA                                              INT  13
            NP=NPPS(J)                                                  INT  14
            DO 5 I=1,NP                                                 INT  15
            ZDIF=Z-ZPT(I,J)                                             INT  16
            IF (ZDIF.GT.0.) GO TO 5                                     INT  17
            I2=I                                                        INT  18
            I1=I-1                                                      INT  19
            GO TO 10                                                    INT  20
          5 CONTINUE                                                    INT  21
         10 IF (I1.EQ.0) GO TO 15                                       INT  22
            R=(Z-ZPT(I1,J))/(ZPT(I2,J)-ZPT(I1,J))                       INT  23
            VMG(J)=STAT(VMAG(I1,J),VMAG(I2,J))                          INT  24
            VDR(J)=STAT(VDIR(I1,J),VDIR(I2,J))                          INT  25
            GO TO 20                                                    INT  26
         15 VMG(J)=VMAG(I2,J)                                           INT  27
            VDR(J)=VDIR(I2,J)                                           INT  28
         20 CONTINUE                                                    INT  29
            NS=NSTA-1                                                   INT  30
            GO TO (25,45,50), NS                                        INT  31
         25 X1=XPT(1)                                                   INT  32
            X2=XPT(2)                                                   INT  33
            Y1=YPT(1)                                                   INT  34
            Y2=YPT(2)                                                   INT  35
            IF (X1-X2.NE.0.0) GO TO 30                                  INT  36
            X3=X1                                                       INT  37
            Y3=Y                                                        INT  38
            GO TO 40                                                    INT  39
         30 IF (Y1-Y2.NE.0.0) GO TO 35                                  INT  40
            X3=X                                                        INT  41
            Y3=Y1                                                       INT  42
            GO TO 40                                                    INT  43
         35 SM1=(Y2-Y1)/(X2-X1)                                         INT  44
            SM1=(Y2-Y1)/(X2-X1)                                         INT  45
            SM2=-1./SM1                                                 INT  46
            DS=SM2-SM1                                                  INT  47
            X3=((Y1-SM1*X1)-(Y-SM2*X))/DS                               INT  48
            Y3=((X1+SM2*Y1)+(X+SM1*Y))/DS                               INT  49
         40 S1=SQRT((X2-X1)**2+(Y2-Y1)**2)                              INT  50
            S2=SQRT((X3-X1)**2+(Y3-Y1)**2)                              INT  51
            SOS=S2/S1                                                   INT  52
            V1(1)=SOS*(VMG(2)-VMG(1))+VMG(1)                            INT  53
            V2(1)=SOS*(VDR(2)-VDR(1))+VDR(1)                            INT  54
            GO TO 55                                                    INT  55
         45 CALL SET (1)                                                INT  56
            CALL CRAMER (V1(1))                                         INT  57
```

```
      CALL SET (2)                                            INT  58
      CALL CRAMER (V2(1))                                     INT  59
      GO TO 55                                                INT  60
   50 CALL SET (1)                                            INT  61
      CALL CRAMER (V1(1))                                     INT  62
      CALL SET (2)                                            INT  63
      CALL CRAMER (V2(1))                                     INT  64
      CALL SET (3)                                            INT  65
      CALL CRAMER (V2(2))                                     INT  66
      CALL SET (4)                                            INT  67
      CALL CRAMER (V1(2))                                     INT  68
      CALL SET (5)                                            INT  69
      CALL CRAMER (V1(3))                                     INT  70
      CALL SET (6)                                            INT  71
      CALL CRAMER (V2(3))                                     INT  72
      CALL SET (7)                                            INT  73
      CALL CRAMER (V2(4))                                     INT  74
      CALL SET (8)                                            INT  75
      CALL CRAMER (V1(4))                                     INT  76
      V1(1)=.25*(V1(1)+V1(2)+V1(3)+V1(4))                     INT  77
      V2(1)=.25*(V2(1)+V2(2)+V2(3)+V2(4))                     INT  78
   55 DTR=PI/180.                                             INT  79
      THT=V2(1)*DTR                                           INT  80
      WW(1)=V1(1)*COS(THT)*1.688                              INT  81
      WW(2)=V1(1)*SIN(THT)*1.688                              INT  82
      WW(3)=0.0                                               INT  83
      RETURN                                                  INT  84
      END                                                     INT  85-
```

```
CARD NR. SEVERITY  DETAILS    DIAGNOSIS OF PROBLEM

   31      I                  AN IF STATEMENT MAY BE MORE EFFICIENT THAN A 2 OR 3 BRANCH COMPUTED GO TO STATEMENT.
```

```
      *DECK SET                                                                 SET   1
            SUBROUTINE SET (I)                                                  SET   2
            COMMON /LVEL/ VMAG(25,4),VDIR(25,4),ZPT(25,4),XPT(4),YPT(4),NPPS(4SET   3
           1),NSTA                                                              SET   4
            COMMON /CLET/ X,Y,X1,X2,X3,Y1,Y2,Y3,Z1,Z2,Z3,VDR(4),VMG(4)          SET   5
            GO TO (5,10,15,20,25,30,35,40), I                                   SET   6
          5 CONTINUE                                                            SET   7
            X1=XPT(1)                                                           SET   8
            X2=XPT(2)                                                           SET   9
            X3=XPT(3)                                                           SET  10
            Y1=YPT(1)                                                           SET  11
            Y2=YPT(2)                                                           SET  12
            Y3=YPT(3)                                                           SET  13
            Z1=VMG(1)                                                           SET  14
            Z2=VMG(2)                                                           SET  15
            Z3=VMG(3)                                                           SET  16
            RETURN                                                              SET  17
         10 CONTINUE                                                            SET  18
            Z1=VDR(1)                                                           SET  19
            Z2=VDR(2)                                                           SET  20
            Z3=VDR(3)                                                           SET  21
            RETURN                                                              SET  22
         15 CONTINUE                                                            SET  23
            X3=XPT(4)                                                           SET  24
            Y3=YPT(4)                                                           SET  25
            Z3=VDR(4)                                                           SET  26
            RETURN                                                              SET  27
         20 CONTINUE                                                            SET  28
            Z1=VMG(1)                                                           SET  29
            Z2=VMG(2)                                                           SET  30
            Z3=VMG(4)                                                           SET  31
            RETURN                                                              SET  32
         25 CONTINUE                                                            SET  33
            X1=XPT(3)                                                           SET  34
            Y1=YPT(3)                                                           SET  35
            Z1=VMG(3)                                                           SET  36
            RETURN                                                              SET  37
         30 CONTINUE                                                            SET  38
            Z1=VDR(3)                                                           SET  39
            Z2=VDR(2)                                                           SET  40
            Z3=VDR(4)                                                           SET  41
            RETURN                                                              SET  42
         35 CONTINUE                                                            SET  43
            X2=XPT(1)                                                           SET  44
            Y2=YPT(1)                                                           SET  45
            Z2=VDR(1)                                                           SET  46
            RETURN                                                              SET  47
         40 CONTINUE                                                            SET  48
            Z1=VMG(3)                                                           SET  49
            Z2=VMG(1)                                                           SET  50
            Z3=VMG(4)                                                           SET  51
            RETURN                                                              SET  52
            END                                                                 SET  53
```

```
      *DECK CRAMER                                                      CRA    1
            SUBROUTINE CRAMER (ANS)                                     CRA    2
            COMMON /CLET/ X,Y,Z1,X2,X3,Y1,Y2,Y3,Z1,Z2,Z3,VDH(4),VMG(4)  CRA    3
            D=X1*(Y2*Z3-Y3*Z2)-Y1*(X2*Z3-X3*Z2)+Z1*(X2*Y3-Y2*X3)        CRA    4
            AN=-(Y2*Z3-Y3*Z2)-Y1*(Z2-Z3)-Z1*(Y3-Y2)                     CRA    5
            BN=X1*(Z2-Z3)+(X2*Z3-X3*Z2)+Z1*(X3-X2)                      CRA    6
            CN=X1*(Y3-Y2)-Y1*(X3-X2)-(X2*Y3-Y2*X3)                      CRA    7
            IF (D.NE.0) GO TO 5                                         CRA    8
            ANS=-(AN*X+BN*Y)/CN                                         CRA    9
            RETURN                                                      CRA   10
          5 A=AN/D                                                      CRA   11
            B=BN/D                                                      CRA   12
            C=CN/D                                                      CRA   13
            ANS=-(1./C)*(1.+A*X+B*Y)                                    CRA   14
            RETURN                                                      CRA   15
            END                                                         CRA   16-
```

```
*DECK SORT
      SUBROUTINE SORT (NDEV,INTAPE)
      COMMON /B1/ FEJUNC
      COMMON /TANDRG/ TDCAB(22),TUDCAB(1000)
      DIMENSION DATIT(2150,10), FEJUNC(3,44)
      EQUIVALENCE (DATIT(1),FEJUNC(1))
      READ (INTAPE,70) ((DATIT(I,J),J=1,10),I=1,NDEV)
C
C     COUNT NUMBER OF DCAB CARDS
C
      K=0
      DO 5 I=1,NDEV
      IF (DATIT(I,2).EQ.4HDCAB) K=K+1
    5 CONTINUE
      NDCAB=K
C
C     PUT DJNC CARDS AFTER DCAB CARDS
C
      NDJNC=NDEV-NDCAB
      IF (NDJNC.EQ.0) GO TO 40
      K=NDCAB+1
      DO 20 I=1,NDCAB
      IF (DATIT(I,2).NE.4HDJNC) GO TO 20
   10 IF (DATIT(K,2).NE.4HDJNC) GO TO 15
      K=K+1
      GO TO 10
   15 CALL SWAP (I,K)
      IF (K.EQ.NDEV) GO TO 25
   20 CONTINUE
   25 CONTINUE
C
C     SORT DJNC CARDS BY JUNCTION NUMBERS
C
      IF (NDJNC.EQ.1) GO TO 40
      NS=NDCAB+1
      ND1=NDEV-1
      DO 35 I=NS,ND1
      I1=I+1
      DO 30 K=I1,NDEV
      IF (DATIT(I,3).LE.DATIT(K,3)) GO TO 30
      CALL SWAP (I,K)
   30 CONTINUE
   35 CONTINUE
   40 CONTINUE
      IF (NDCAB.LE.1) RETURN
C
C     SORT DCAB CARDS BY CABLE NUMBER
C
      NDCAB1=NDCAB-1
      DO 50 I=1,NDCAB1
      I1=I+1
      DO 45 K=I1,NDCAB
      IF (DATIT(I,3).LE.DATIT(K,3)) GO TO 45
      CALL SWAP (I,K)
   45 CONTINUE
   50 CONTINUE
C
```

```
      C     SORT BY UNSTRESSED DISTANCE FORM S=0 JUNCTION OF CABLE      SOR  58
      C                                                                 SOR  59
            DO 65 I=1,NDCAB1                                            SOR  60
            K=I+1                                                       SOR  61
         55 IF (DATI1(I,3).NE.DATI1(K,3)) GO TO 65                      SOR  62
            IF (DATI1(I,10).LE.DATI1(K,10)) GO TO 60                    SOR  63
            CALL SWAP (I,K)                                             SOR  64
         60 K=K+1                                                       SOR  65
            IF (K.GT.NDCAB) GO TO 65                                    SOR  66
            GO TO 55                                                    SOR  67
         65 CONTINUE                                                    SOR  68
            RETURN                                                      SOR  69
      C                                                                 SOR  70
         70 FORMAT (F4.0,A4,8F8.0)                                      SOR  71
            END                                                         SOR  72-
```

```
      *DECK SWAP                                                  SWA   1
            SUBROUTINE SWAP (I,K)                                 SWA   2
            COMMON /B1/ FEJUNC                                    SWA   3
            COMMON /TANCHG/ TCCAB(22),TDDCAB(1000)                SWA   4
            DIMENSION DATIT(2150,10), TDATA(10), FEJUNC(3,44)     SWA   5
            EQUIVALENCE (DATIT(1),FEJUNC(1))                      SWA   6
            DO 5 J=1,10                                           SWA   7
            TDATA(J)=DATIT(I,J)                                   SWA   8
            DATIT(I,J)=DATIT(K,J)                                 SWA   9
          5 DATIT(K,J)=TDATA(J)                                   SWA  10
            TEMP=TDDCAB(I)                                        SWA  11
            TDDCAB(I)=TDDCAB(K)                                   SWA  12
            TDDCAB(K)=TEMP                                        SWA  13
            RETURN                                                SWA  14
            END                                                   SWA  15-
```

```
*DECK BADATA                                                           BAD   1
      SUBROUTINE BADATA                                                BAD   2
C                                                                      BAD   3
C     THIS SUBROUTINE PRINTS OUT THE INPUT DECK IF                     BAD   4
C     AN ERROR HAS BEEN DETECTED,NOTES THE ERRORS                      BAD   5
C     AND PRINTS THE TEXT  DESCRIBING THE ERRORS                       BAD   6
C                                                                      BAD   7
      DIMENSION IERR(58), TYPE(58), CARD(58)                           BAD   8
      DIMENSION ICAB(22), ICHECK(44), TITLE(8)                         BAD   9
      DIMENSION NNODE(22), ERJUNC(44), IRJUNC(44), DATI(10), DATN(10), HBAD  10
     1(22)                                                             BAD  11
      DIMENSION PJUNC(3,44), CDCAB(22), DCAB(22), ANJUNC(44)           BAD  12
      COMMON /B1N/ ISCR                                                BAD  13
      COMMON /B2/ NCAB,NNODE,ERJUNC,IRJUNC,DATI,DATN,H,PJUNC,CDCAB,DCAB,BAD  14
     1FATE,NANC,ANJUNC,IREAD,IPRNT                                     BAD  15
C                                                                      BAD  16
C     DATA STATEMENTS                                                  BAD  17
C                                                                      BAD  18
      DATA TYPE/3H  0,3H 1A,3H 1B,3H 1C,3H 1A,3H 1A,3H 1A,3H 1B,3H 1A,3HBAD  19
     1 1B,3H 1C,3H 1D,3H 1E,3H 1F,3H 1G,3H 1H,3H 1A,3H 1B,3H 1C,3H 1D,3HBAD  20
     2 1E,3H 1F,3H 1A,3H 1B,3H 1A,3H 1A,3H 1A,3H 1A,3H 1B,3H 2A,3H 2A,3HBAD  21
     3  3,3H 4A,3H 4B,3H 6A,3H 6A,3H 6A,3H 6A,3H 6B,3H 6A,3H  7,3H  8,3HBAD  22
     4  9,3H 11,3H12A,3H12B,3H12C,3H12A,3H12A,3H12B,3H12A,3H 13,3H14A,3HBAD  23
     514B,3H 15,3H 16,3H 17,3H 18/                                     BAD  24
      DATA CARD/4H    ,4H LUN,4H LUN,4H LUN,4HNJNC,4H ANC,4H  IR,4H  IR,BAD  25
     14H CAB,4H CAB,4H CAB,4H CAB,4H CAB,4H CAB,4H CAB,4H CAB,4HDCAB,4HDBAD  26
     2CAB,4HDCAB,4HDCAB,4HDCAB,4HDCAB,4HDJNC,4HDJNC,4H DEN,4HNDAT,4HCOMPBAD  27
     3,4H ANG,4H ANG,4H ANC,4H CAB,4H CAB,4H  IR,4H  IR,4HNJNC,4H DEN,4HHBAD  28
     4COMP,4H VEL,4H VEL,4H ANG,4H    ,4H    ,4H    ,4H    ,4H  IR,4H  IBAD  29
     5R,4H  IR,4H CAB,4HDCAB,4HDCAB,4HDJNC,4H    ,4H    ,4H    ,4H    ,4BAD  30
     6H    ,4H    ,4H    /                                             BAD  31
C                                                                      BAD  32
C     WRITE END OF FILE AND REWIND UNIT ISCR                           BAD  33
C                                                                      BAD  34
      END FILE ISCR                                                    BAD  35
      REWIND ISCR                                                      BAD  36
C                                                                      BAD  37
C     INITIALIZE ARRAY INDICATING ERROR TYPES                          BAD  38
C                                                                      BAD  39
      NER=58                                                           BAD  40
      DO 5 I=1,NER                                                     BAD  41
    5 IERR(I)=0                                                        BAD  42
C                                                                      BAD  43
C     PRINT HEADER FOR ERRORS                                          BAD  44
C                                                                      BAD  45
      WRITE (IPRNT,365)                                                BAD  46
C                                                                      BAD  47
C     READ FORMAT AND ERROR CODE FOR SUBSEQUENT CARD                   BAD  48
C                                                                      BAD  49
   10 READ (ISCR) IFORM,IBAD                                           BAD  50
      IF (EOF(ISCR)) 55,15                                             BAD  51
   15 IF (IBAD.NE.0) IERR(IBAD)=1                                      BAD  52
      GO TO (20,20,20,25,30,35,40,45,50), IFORM                        BAD  53
C                                                                      BAD  54
C     READ AND PRINT INPUT CARD IMAGES                                 BAD  55
C                                                                      BAD  56
   20 READ (ISCR,355) TITLE                                            BAD  57
```

```
      WRITE (IPRNT,360) TITLE                                           BAD  58
      GO TO 10                                                          BAD  59
C                                                                       BAD  60
C     READ AND PRINT ERROR TYPES AND OTHER INFORMATION                  BAD  61
C                                                                       BAD  62
   25 WRITE (IPRNT,375) TYPE(IBAD)                                      BAD  63
      GO TO 10                                                          BAD  64
   30 READ (ISCR) IFJNC,IFRHO,NANC                                      BAD  65
      WRITE (IPRNT,375) TYPE(IBAD),IFJNC,IFRHO,NANC                     BAD  66
      GO TO 10                                                          BAD  67
   35 READ (ISCR) NCOMP,IVOPT,NVSEG,NZL,NANG                            BAD  68
      WRITE (IPRNT,375) TYPE(IBAD),NCOMP,IVOPT,NVSEG,NZL,NANG           BAD  69
      GO TO 10                                                          BAD  70
   40 READ (ISCR) (ICAB(I),I=1,22)                                      BAD  71
      WRITE (IPRNT,380) TYPE(IBAD),(ICAB(I),I=1,22)                     BAD  72
      GO TO 10                                                          BAD  73
   45 READ (ISCR) (ICHECK(I),I=1,44)                                    BAD  74
      WRITE (IPRNT,380) TYPE(IBAD),(ICHECK(I),I=1,44)                   BAD  75
      GO TO 10                                                          BAD  76
   50 READ (ISCR) NCAB,NANC,NOJUNC,NIRC,NIR                             BAD  77
      WRITE (IPRNT,375) TYPE(IBAD),NCAB,NANC,NOJUNC,NIRC,NIR            BAD  78
      GO TO 10                                                          BAD  79
C                                                                       BAD  80
C     PRINT TEXT OF ERRORS                                              BAD  81
C                                                                       BAD  82
   55 WRITE (IPRNT,370)                                                 BAD  83
      DO 350 I=1,NER                                                    BAD  84
      IF (IERR(I).EQ.0) GO TO 350                                       BAD  85
      WRITE (IPRNT,385) TYPE(I),CARD(I)                                 BAD  86
      GO TO (60,65,70,75,80,85,90,95,100,105,110,115,120,125,130,135,140BAD  87
     1,145,150,155,160,165,170,175,180,185,190,195,200,205,210,215,220,2BAD  88
     225,230,235,240,245,250,255,260,265,270,275,280,285,290,295,300,305BAD  89
     3,310,315,320,325,330,335,340,345), I                              BAD  90
   60 WRITE (IPRNT,390)                                                 BAD  91
      GO TO 350                                                         BAD  92
   65 WRITE (IPRNT,395)                                                 BAD  93
      GO TO 350                                                         BAD  94
   70 WRITE (IPRNT,400)                                                 BAD  95
      GO TO 350                                                         BAD  96
   75 WRITE (IPRNT,405)                                                 BAD  97
      GO TO 350                                                         BAD  98
   80 WRITE (IPRNT,410)                                                 BAD  99
      GO TO 350                                                         BAD 100
   85 WRITE (IPRNT,415)                                                 BAD 101
      GO TO 350                                                         BAD 102
   90 WRITE (IPRNT,420)                                                 BAD 103
      GO TO 350                                                         BAD 104
   95 WRITE (IPRNT,425)                                                 BAD 105
      GO TO 350                                                         BAD 106
  100 WRITE (IPRNT,430)                                                 BAD 107
      GO TO 350                                                         BAD 108
  105 WRITE (IPRNT,435)                                                 BAD 109
      GO TO 350                                                         BAD 110
  110 WRITE (IPRNT,440)                                                 BAD 111
      GO TO 350                                                         BAD 112
  115 WRITE (IPRNT,445)                                                 BAD 113
      GO TO 350                                                         BAD 114
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  120 WRITE (IPRNT,450)                                        BAD 115
      GO TO 350                                                BAD 116
  125 WRITE (IPRNT,455)                                        BAD 117
      GO TO 350                                                BAD 118
  130 WRITE (IPRNT,460)                                        BAD 119
      GO TO 350                                                BAD 120
  135 WRITE (IPRNT,465)                                        BAD 121
      GO TO 350                                                BAD 122
  140 WRITE (IPRNT,470)                                        BAD 123
      GO TO 350                                                BAD 124
  145 WRITE (IPRNT,475)                                        BAD 125
      GO TO 350                                                BAD 126
  150 WRITE (IPRNT,480)                                        BAD 127
      GO TO 350                                                BAD 128
  155 WRITE (IPRNT,485)                                        BAD 129
      GO TO 350                                                BAD 130
  160 WRITE (IPRNT,490)                                        BAD 131
      GO TO 350                                                BAD 132
  165 WRITE (IPRNT,495)                                        BAD 133
      GO TO 350                                                BAD 134
  170 WRITE (IPRNT,500)                                        BAD 135
      GO TO 350                                                BAD 136
  175 WRITE (IPRNT,505)                                        BAD 137
      GO TO 350                                                BAD 138
  180 WRITE (IPRNT,510)                                        BAD 139
      GO TO 350                                                BAD 140
  185 WRITE (IPRNT,515)                                        BAD 141
      GO TO 350                                                BAD 142
  190 WRITE (IPRNT,520)                                        BAD 143
      GO TO 350                                                BAD 144
  195 WRITE (IPRNT,525)                                        BAD 145
      GO TO 350                                                BAD 146
  200 WRITE (IPRNT,530)                                        BAD 147
      GO TO 350                                                BAD 148
  205 WRITE (IPRNT,535)                                        BAD 149
      GO TO 350                                                BAD 150
  210 WRITE (IPRNT,540)                                        BAD 151
      GO TO 350                                                BAD 152
  215 WRITE (IPRNT,545)                                        BAD 153
      GO TO 350                                                BAD 154
  220 WRITE (IPRNT,550)                                        BAD 155
      GO TO 350                                                BAD 156
  225 WRITE (IPRNT,555)                                        BAD 157
      GO TO 350                                                BAD 158
  230 WRITE (IPRNT,560)                                        BAD 159
      GO TO 350                                                BAD 160
  235 WRITE (IPRNT,565)                                        BAD 161
      GO TO 350                                                BAD 162
  240 WRITE (IPRNT,570)                                        BAD 163
      GO TO 350                                                BAD 164
  245 WRITE (IPRNT,575)                                        BAD 165
      GO TO 350                                                BAD 166
  250 WRITE (IPRNT,580)                                        BAD 167
      GO TO 350                                                BAD 168
  255 WRITE (IPRNT,585)                                        BAD 169
      GO TO 350                                                BAD 170
  260 WRITE (IPRNT,590)                                        BAD 171
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      GO TO 350                                                         BAD 172
  265 WRITE (IPRNT,595)                                                 BAD 173
      GO TO 350                                                         BAD 174
  270 WRITE (IPRNT,600)                                                 BAD 175
      GO TO 350                                                         BAD 176
  275 WRITE (IPRNT,605)                                                 BAD 177
      GO TO 350                                                         BAD 178
  280 WRITE (IPRNT,610)                                                 BAD 179
      GO TO 350                                                         BAD 180
  285 WRITE (IPRNT,615)                                                 BAD 181
      GO TO 350                                                         BAD 182
  290 WRITE (IPRNT,620)                                                 BAD 183
      GO TO 350                                                         BAD 184
  295 WRITE (IPRNT,625)                                                 BAD 185
      GO TO 350                                                         BAD 186
  300 WRITE (IPRNT,630)                                                 BAD 187
      GO TO 350                                                         BAD 188
  305 WRITE (IPRNT,635)                                                 BAD 189
      GO TO 350                                                         BAD 190
  310 WRITE (IPRNT,640)                                                 BAD 191
      GO TO 350                                                         BAD 192
  315 WRITE (IPRNT,645)                                                 BAD 193
      GO TO 350                                                         BAD 194
  320 WRITE (IPRNT,650)                                                 BAD 195
      GO TO 350                                                         BAD 196
  325 WRITE (IPRNT,655)                                                 BAD 197
      GO TO 350                                                         BAD 198
  330 WRITE (IPRNT,660)                                                 BAD 199
      GO TO 350                                                         BAD 200
  335 WRITE (IPRNT,665)                                                 BAD 201
      GO TO 350                                                         BAD 202
  340 WRITE (IPRNT,670)                                                 BAD 203
      GO TO 350                                                         BAD 204
  345 WRITE (IPRNT,675)                                                 BAD 205
  350 CONTINUE                                                          BAD 206
C                                                                       BAD 207
C     FORMATS                                                           BAD 208
C                                                                       BAD 209
      RETURN                                                            BAD 210
C                                                                       BAD 211
  355 FORMAT (8A10)                                                     BAD 212
  360 FORMAT (1H ,1X,8A10)                                              BAD 213
  365 FORMAT (1H1,35X,11HINPUT CARDS,35X,5HERROR,13X,17HOTHER INFORMATIOBAD 214
     1N/2X,4H( 1),4H( 2),2H( ,2X,2H3 ,3H )(,3X,5H4   )(,3X,5H5   )(,3X,5H6BAD 215
     2   )(,3X,5H7   )(,3X,5H8   )(,3X,5H9   )(,2X,6H10   )(,8H 11)(12),4X,44BAD 216
     3H12345678901234567890123456789012345678901234/)                   BAD 217
  370 FORMAT (///1X,20HDEFINITION OF ERRORS/)                           BAD 218
  375 FORMAT (1H ,8(1X,1H*,A3,1H*,5I3)                                  BAD 219
  380 FORMAT (1H ,8(1X,1H*,A3,1H*,44I1)                                 BAD 220
  385 FORMAT (/1X,4HTYPE,A3,3H - ,A4)                                   BAD 221
  390 FORMAT (5X,85HA TYPE 0 ERROR INDICATES THAT THE CARD TYPE IDENTIFIBAD 222
     1ER (FIELD 2) IS NOT RECOGNIZABLE.)                                BAD 223
  395 FORMAT (5X,24HFIELD 6 NOT EQUAL 0 OR 1)                           BAD 224
  400 FORMAT (5X,23HFIELD 8 NOT EQUAL 0,1,2)                            BAD 225
  405 FORMAT (5X,49HNON-UNIQUE NUMBERS ASSIGNED TO REQUIRED I/O UNITS)  BAD 226
  410 FORMAT (5X,39HFIELD 3 GREATER THAN 44 OR LESS THAN 2.)            BAD 227
  415 FORMAT (5X,39HFIELD 3 GREATER THAN 44 OR LESS THAN 1.)            BAD 228
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      420 FORMAT (5X,17HFIELD 3 = FIELD 4)                                 BAD 229
      425 FORMAT (5X,45HFIELDS 3 OR 4 GREATER THAN 44 OR LESS THAN 1 )     BAD 230
      430 FORMAT (5X,38HFIELD 3 GREATER THAN 22 OR LESS THAN 1)            BAD 231
      435 FORMAT (5X,17HFIELD 4 = FIELD 5)                                 BAD 232
      440 FORMAT (5X,44HFIELDS 4 OR 5 GREATER THAN 44 OR LESS THAN 1)      BAD 233
      445 FORMAT (5X,39HFIELDS 7,8 OR 9 LESS THAN OR EQUAL TO 0)           BAD 234
      450 FORMAT (5X,27HFIELDS 10 OR 11 LESS THAN 0)                       BAD 235
      455 FORMAT (5X,35HFIELD 10=0 AND FIELD 11 NOT EQUAL 0)               BAD 236
      460 FORMAT (5X,35HFIELD 10 NOT EQUAL 0 AND FIELD 11=0)               BAD 237
      465 FORMAT (5X,39HFIELD 12 GREATER THAN 50 OR LESS THAN 1)           BAD 238
      470 FORMAT (5X,38HFIELD 3 GREATER THAN 22 OR LESS THAN 1)            BAD 239
      475 FORMAT (5X,37HFIELD 4 GREATER THAN 2 OR LESS THAN 1)             BAD 240
      480 FORMAT (5X,40HFIELD 5 GREATER THAN 1000 OR LESS THAN 1)          BAD 241
      485 FORMAT (5X,46HFIELD 4=1 AND FIELD 9 LESS THAN OR EQUAL  TO 0)    BAD 242
      490 FORMAT (5X,33HFIELD 4=2 AND FIELD 9 NOT EQUAL 0)                 BAD 243
      495 FORMAT (5X,28HFIELDS 7,8 OR 10 LESS THAN 0)                      BAD 244
      500 FORMAT (5X,38HFIELD 3 GREATER THAN 44 OR LESS THAN 1)            BAD 245
      505 FORMAT (5X,24HFIELD 7 OR 8 LESS THAN 0)                          BAD 246
      510 FORMAT (5X,19HFIELD 3 LESS THAN 0)                               BAD 247
      515 FORMAT (5X,27HFIELD 3 NOT EQUAL 0,1, OR 2)                       BAD 248
      520 FORMAT (5X,28HFIELD 3 LESS THAN OR EQUAL 0)                      BAD 249
      525 FORMAT (5X,28HFIELD 4 LESS THAN OR EQUAL 0)                      BAD 250
      530 FORMAT (5X,25HFIELD 5 LESS THAN FIELD 3)                         BAD 251
      535 FORMAT (5X,96HTHE JUNCTION NUMBER ASSIGNED TO THE ANCHOR(FIELD 3) BAD 252
         1HAS BEEN ASSIGNED TO A PRECEDING ANC CARD OR/5X,52HTO AN S=L JUNCTBAD 253
         2ION (FIELD 5) ON A PRECEDING CAB CARD)                           BAD 254
      540 FORMAT (5X,104HTHE JUNCTION NUMBER ASSIGNED TO THE S=L JUNCTION (FBAD 255
         1IELD 5) HAS BEEN ASSIGNED  ON A PRECEDING CAB CARD OR/5X,55HTO AN BAD 256
         2ANCHOR JUNCTION (FIELD 3) ON A PRECEDING ANC CARD)               BAD 257
      545 FORMAT (5X,82HA TYPE 3 ERROR APPEARS ONLY IN CONJUNCTION WITH A CABAD 258
         1H CARD AND INDICATES THAT THE /5X,80HNUMBER ASSIGNED TO THE CABLE BAD 259
         2(FIELD 3) HAS BEEN ASSIGNED ON A PRECEDING CAB CARD)             BAD 260
      550 FORMAT (5X,97HTHE JUNCTION NUMBER ASSIGNED IN FIELD 3 HAS BEEN ASSBAD 261
         1IGNED IN FIELDS 3 OR 4 OF A PRECEDING IR CARD)                   BAD 262
      555 FORMAT (5X,91HTHE JUNCTION NUMBER ASSIGNED IN FIELD 4 HAS BEEN ASSBAD 263
         1IGNED IN FIELD 3 OF A PRECEDING IR CARD)                         BAD 264
      560 FORMAT (5X,66HAN NJNC CARD HAS PREVIOUSLY APPEARED IN THE PARTICULBAD 265
         1AR SOURCE DECK)                                                  BAD 266
      565 FORMAT (5X,64HA DEN CARD HAS PREVIOUSLY APPEARED IN THE PARTICULARBAD 267
         1 SOURCE DECK)                                                    BAD 268
      570 FORMAT (5X,65HA COMP CARD HAS PREVIOUSLY APPEARED IN THE PARTICULABAD 269
         1R SOURCE DECK)                                                   BAD 270
      575 FORMAT (5X,77HTWENTY FIVE VEL CARDS HAVE PREVIOUSLY APPEARED IN THBAD 271
         1E  PARTICULAR SOURCE DECK)                                       BAD 272
      580 FORMAT (5X,74HTHE Z COORDINATE AT WHICH THE CURRENT VELOCITY IS SPBAD 273
         1ECIFIED (FIELD 3) HAS /5X,63HBEEN USED ON A PRECEDING VEL CARD IN BAD 274
         2THE PARTICULAR SOURCE DECK)                                      BAD 275
      585 FORMAT (5X,65HAN ANG CARD HAS PREVIOUSLY APPEARED IN THE PARTICULABAD 276
         1R SOURCE DECK)                                                   BAD 277
      590 FORMAT (5X,116HA TYPE 7 ERROR INDICATES AN INADEQUACY OF INFORMATIBAD 278
         1ON IN THE CABLE ARRAY SOURCE DECK(OR TAPE). THE OTHER INFORMATION/BAD 279
         25X,119HCOLUMN  UNDER THE ERROR HEADING CONTAINS A 1X3 MATRIX. THE BAD 280
         3ELEMENTS OF WHICH GIVE RESPECTIVELY THE NUMBER OF NJNC CARDS/5X,12BAD 281
         4HREAD, THE NUMBER OF DEN CARDS READ, AND THE NUMBER OF ANC CARDS BAD 282
         5READ. A ZERO ELEMENT IS AN ERROR(SEE CABLE ARRAY SOURCE DECK))   BAD 283
      595 FORMAT (5X,114HA TYPE 8 ERROR INDICATES A DISCONTINUITY IN NUMBERIBAD 284
         1NG THE CABLES IN THE ARRAY. THE OTHER INFORMATION COLUMN UNDER /5XBAD 285
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     2,121HTHE ERROR HEADING CONTAINS A 1X22 MATRIX, THE ELEMENTS OF WHIBAD 286
     3CH  CONTAIN ONE OR ZERO INDICATNG, RESPECTIVELY, THE USE OR /5X,12BAD 287
     47HNON-USE OF THE CORRESPONDING COLUMN NUMBER AS A CABLE NUMBER. ZEBAD 288
     5ROS INTERSPERSED WITH ONES ARE IN ERROR (SEE ARRAY DESCRIPTION)) BAD 289
 600 FORMAT (5X,111HA TYPE 9 ERROR INDICATES A DISCONTINUITY IN NUMBERIBAD 290
     1NG THE JUNCTIONS IN THE ARRAY. THE OTHER INFORMATION COLUMN /5X,12BAD 291
     20HUNDER THE ERROR HEADING CONTAINS A 1 X 44 MATRIX, THE ELEMENTS OBAD 292
     3F WHICH CONTAIN ONE OR ZERO INDICATING RESPECTIVELY, THE/5X,113HUSBAD 293
     4E OR NON-USE OF THE CORRESPONDING COLUMN NUMBER AS A JUNCTION NUMBBAD 294
     5ER. ZEROS INTERSPERSED WITH ONES ARE IN ERROR/5X,72H(SEE ARRAY DESBAD 295
     6CRIPTION AND REDUCTION TO A STATICALLY DETERMINATE ARRAY).)      BAD 296
 605 FORMAT (5X,116HA TYPE 11 ERROR INDICATES AN IMPROPER REDUCTION OF BAD 297
     1THE ORIGINAL CABLE ARRAY TO A STATICALLY DETERMINATE ARRAY OR AN /BAD 298
     25X,124HABSENCE OF CERTAIN INPUT CARDS IN THE CABLE ARRAY SOURCE DEBAD 299
     3CK(OR TAPE). THE OTHER INFORMATION COLUMN UNDER THE ERROR HEADING/BAD 300
     45X,122HCONTAINS A 1 X 5 MATRIX. THE ELEMENTS OF WHICH GIVE, RESPECBAD 301
     5TIVELY,  THE NUMBER OF CAB CARDS READ, THE NUMBER OF ANC CARDS /5XBAD 302
     6,121HREAD, THE NUMBER OF JUNCTIONS IN THE ORIGINAL CABLE ARRAY(FIEBAD 303
     7LD 3 OF THE NJNC CARD), THE NUMBER OF REQUIRED CUTS (EQ.(1))/5X,11BAD 304
     89HCALCULATED FROM THE PRECEDING INFORMATION, AND THE NUMBER OF IR BAD 305
     9CARDS READ. COLUMN 5 NOT EQUAL TO COLUMN 4 IS AN ERROR /5X,50H(SEEBAD 306
     $ REDUCTION TO A STATICALLY DETERMINATE ARRAY).)                  BAD 307
 610 FORMAT (5X,104HTHE JUNCTION NUMBER ASSIGNED IN FIELD 3 IS LESS THABAD 308
     1N OR EQUAL TO THE NUMBER OF JUNCTIONS IN THE ORIGINAL/5X,43H(UNREDBAD 309
     2UCED) ARRAY(FIELD 3 OF THE NJNC CARD))                           BAD 310
 615 FORMAT (5X,113HTHE JUNCTION NUMBER ASSIGNED IN FIELD 3 IS GREATER BAD 311
     1THAN THE NUMBER OF JUNCTIONS IN THE ORIGINAL (UNREDUCED) ARRAY/5X,BAD 312
     259HPLUS THE NUMBER OF CUTS MADE IN REDUCING THE ARRAY (EQ.(1)))  BAD 313
 620 FORMAT (5X,113HTHE JUNCTION NUMBER ASSIGNED IN FIELD 4 IS GREATER BAD 314
     1THAN THE NUMBER OF JUNCTIONS IN THE ORIGINAL (UNREDUCED) ARRAY)  BAD 315
 625 FORMAT (5X,107HTHE JUNCTION NUMBER ASSIGNED IN FIELD 4 IS GREATER BAD 316
     1THAN THE NUMBER OF JUNCTIONS IN THE ORIGINAL (UNREDUCED)/5X,92HARRBAD 317
     2AY (FIELD 3 OF THE NJNC CARD) PLUS THE NUMBER OF CUTS MADE IN REDUBAD 318
     3CING THE ARRAY (EQ.(1)))                                         BAD 319
 630 FORMAT (5X,121HTHE CABLE NUMBER ASSIGNED IN FIELD 3 DOES NOT CORREBAD 320
     1SPOND TO A CABLE NUMBER ASSIGNED TO A CABLE (FIELD 3 OF THE CAB CABAD 321
     2RDS))                                                            BAD 322
 635 FORMAT (5X,110HTHE DISTANCE OF THE DISCRETE DEVICE FROM THE S=0 JUBAD 323
     1NCTION OF THE CABLE (FIELD 10) IS GREATER THAN OR EQUAL TO /5X,63HBAD 324
     2THE LENGTH OF THE CORRESPONDING CABLE (FIELD 9 OF THE CAB CARD)) BAD 325
 640 FORMAT (5X,100HTHE JUNCTION NUMBER ASSIGNED IN FIELD 3 DOES NOT COBAD 326
     1RRESPOND TO EITHER A JUNCTION NUMBER ASSIGNED TO AN ANCHOR/5X,114HBAD 327
     2(FIELD 3 OF THE ANC CARDS) OR A JUNCTION NUMBER ASSIGNED TO AN S=LBAD 328
     3 JUNCTION OF A CABLE (FIELD 5 OF THE CAB CARDS).)                BAD 329
 645 FORMAT (5X,102HA TYPE 13 ERROR INDICATES THAT THE ORIGINAL CABLE ABAD 330
     1RRAY HAS NOT BEEN PROPERLY REDUCED TO A STATICALLY /5X,101HDETERMIBAD 331
     2NATE ARRAY OR THAT JUNCTIONS HAVE BEEN IMPROPERLY NUMBERED. THE OTBAD 332
     3HER INFORMATION COLUMN UNDER/5X,98HTHE ERROR HEADING CONTAINS THE BAD 333
     4MESSAGE,IMPROPER ARRAY REDUCTION OR JUNCTION NUMBERING.  CHECK THEBAD 334
     5E/5X,110HREPRESENTATION OF ARRAY (SEE ARRAY REDUCTION SECTION OF UBAD 335
     6SERS MANUAL) AGAINST JUNCTION NUMBERING ON ANC AND CAB CARDS.)   BAD 336
 650 FORMAT (5X,112HA TYPE 14 ERROR INDICATES AN INADEQUACY OF INFORMATBAD 337
     1ION IN A PARAMETRIC STUDY SOURCE DECK. THE OTHER INFORMATION /5X,1BAD 338
     222HCOLUMN UNDER THE ERROR HEADING CONTAINS A 1 X 4 MATRIX. THE ELEBAD 339
     3MENTS OF WHICH GIVE, RESPECTIVELY, THE NUMBER OF COMP CARDS/5X,121BAD 340
     4HREAD, THE CURRENT FIELD OPTION, THE NUMBER OF VEL CARDS READ, THEBAD 341
     5 NUMBER OF VEL CARDS CONTAINING A / COORDINATE (FIELD 3)/5X,111HLEBAD 342
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     LSS THAN OR EQUAL TO THE MINIMUM Z COORDINATE TRANSMITTED BY THE ANBAD 343
     7C CARDS (FIELD 6 OF THE ANC CARDS), AND THE/5X,25HNUMBER OF ANG CABAD 344
     8RDS READ./5X,125HIF COLUMN 1 CONTAINS A ZERO. THEN A COMP CARD HASBAD 345
     9 NOT APPEARED AFTER THE FIRST NDAT CARD (SEE PARAMETRIC STUDY SOURBAD 346
     $CE DECKS).)                                                      BAD 347
 655 FORMAT (5X,112HA TYPE 14 ERROR INDICATES AN INADEQUACY OF INFORMATBAD 348
     1ION IN A PARAMETRIC STUDY SOURCE DECK. THE OTHER INFORMATION /5X,1BAD 349
     222HCOLUMN UNDER THE ERROR HEADING CONTAINS A 1 X 5 MATRIX. THE ELEBAD 350
     3MENTS OF WHICH GIVE, RESPECTIVELY, THE NUMBER OF COMP CARDS/5X,121HBAD 351
     4HREAD, THE CURRENT FIELD OPTION, THE NUMBER OF VEL CARDS READ, THEBAD 352
     5 NUMBER OF VEL CARDS CONTAINING A Z COORDINATE (FIELD 3)/5X,111HLEBAD 353
     6SS THAN OR EQUAL TO THE MINIMUM Z COORDINATE TRANSMITTED BY THE ANBAD 354
     7C CARDS (FIELD 6 OF THE ANC CARDS), AND THE/5X,25HNUMBER OF ANG CABAD 355
     8RDS READ./5X,117HIF COLUMN 2 CONTAINS A ONE AND ANY OF COLUMNS 3,4BAD 356
     9, OR 5 CONTAIN A ZERO, THEN THE STANDARD CURRENT FIELD HAS NOT BEEBAD 357
     $N /5X,83HPROPERLY FORMULATED (SEE PARAMETRIC STUDY SOURCE DECKS ANBAD 358
     $D STANDARD CURRENT FIELD).)                                      BAD 359
 660 FORMAT (5X,106HA TYPE 15 ERROR INDICATES THAT AN UNPERMITTED CHANGBAD 360
     1E HAS BEEN ATTEMPTED IN A PARAMETRIC STUDY SOURCE DECK./5X,36H(SEEBAD 361
     2 PARAMETRIC STUDY SOURCE DECKS).)                                BAD 362
 665 FORMAT (5X,114HA TYPE 16 ERROR INDICATES AN IMPROPER DECK STRUCTURBAD 363
     1E.  SEE CABLE ARRAY SOURCE DECK, PARAMETRIC STUDY SOURCE DECKS,/5XBAD 364
     2,22HAND OVERALL INPUT DECK)                                      BAD 365
 670 FORMAT (5X,101HA TYPE 17 ERROR INDICATES THAT THE CABLE ARRAY SOURBAD 366
     1CE DECK (OR TAPE) CONTAINS MORE THAN 2150 RECORDS./5X,119HTHE OTHEBAD 367
     2R INFORMATION COLUMN UNDER THE ERROR HEADING CONTAINS THE MESSAGE BAD 368
     3COMMON/B1/ MOLDUS EXCEEDED. SEE USERS MANUAL./5X,125HA TYPE 17 ERRBAD 369
     4OR IS READILY CORRECTABLE IF THE MACHINE BEING USED HAS SUFFICIENTBAD 370
     5 CORE STORAGE. THIS CORRECTION IS ACHIEVED BY /5X,124HCHANGING THEBAD 371
     6 ROW DIMENSION OF DATIT ON CARDS DES025 AND INP022 FROM 2150 TO A BAD 372
     7NUMBER EXCEEDING THE NUMBER OF RECORDS IN THE /5X,123HCABLE ARRAY BAD 373
     8SOURCE DECK (OR TAPE). SUMULTANEOUSLY, THE COMPARISON VALUE ON CARBAD 374
     9D INP015 MUST BE CHANGED FROM 2150 TO THE NEW/5X,23HROW DIMENSION BAD 375
     $OF DATIT.)                                                       BAD 376
 675 FORMAT (5X,108HA TYPE 18 ERROR INDICATES THAT THE ACCURACY REQUIREBAD 377
     1D FOR THE ARRAY EQUILIBRIUM CALCULATIONS (FIELD 3 OF THE /5X,9AHCOBAD 378
     2MP CARD) HAS NOT BEEN OBTAINED DURING THE CALCULATIONS. THIS IS FOBAD 379
     3R ONE OF TWO POSSIBLE REASONS.//5X,116HA.  SOME CABLE SEGMENTS HAVBAD 380
     4E GONE SLACK(THAT IS. THE SEGMENTS HAVE NEAR ZERO TENSION. AN EXAMBAD 381
     5INATION OF THE TENSIONS/5X,112HPRINTED OUT IN CONJUNCTION WITH A TBAD 382
     6YPE 18 ERROR WILL REVEAL IF THIS IS THE REASON. IF IT IS. SEE THE BAD 383
     7SECTION ON /5X,91HSTATICALLY UNSTABLE CABLE ARRAYS IN REF. 2 FOR PBAD 384
     8OSSIBLE REMEDIAL ACTIONS. IF IT IS NOT THEN//5X,12HB.  THE ACCURABAD 385
     9CY REQUIRED FOR THE EQUILIBRIUM CALCULATIONS IS SIMPLY TOO STRINGEBAD 386
     $NT FOR THE COMPUTER TO HANDLE (SEE COMP CARD)./5X,120HAN EXAMINATIBAD 387
     $ON OF THE FINAL VALUE OF THE ACCURACY OBTAINED, PRINTED OUT IN CONBAD 388
     $JUNCTION WITH A TYPE 18 ERROR, WILL REVEAL/5X,102HTHE BEST ACCURACBAD 389
     $Y OBTAINABLE. FIELD 3 OF THE COMP CARD SHOULD BE MODIFIED TO REFLEBAD 390
     $CT THIS INFORMATION.)                                            BAD 391
      END                                                              BAD 392-
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*DECK CPLT                                                              CPL   1
      SUBROUTINE CPLT (IVOPT,IPRNT,PJUNC,NANC,TITLE,ANJUNC)             CPL   2
      COMMON /CPT/ ZUP,ZDN,DZ,XMIN,XMAX,YMIN,YMAX,YIN,ANG,NY            CPL   3
      COMMON /PIBLK/ PI                                                 CPL   4
      DIMENSION PJUNC(3,44), ANJUNC(44)                                 CPL   5
      DIMENSION X(100), Y(100)                                          CPL   6
      DIMENSION PSPACE(3), WW(3), TITLE(8)                              CPL   7
      INTEGER ANJUNC                                                    CPL   8
C                                                                       CPL   9
C     SET UP PERSPECTIVE TRANSFORMATIONS                                CPL  10
C                                                                       CPL  11
      UP(XP,YP)=XP+YP*EX                                                CPL  12
      VP(YP)=YP*EY                                                      CPL  13
C                                                                       CPL  14
C     INITIALIZATION                                                    CPL  15
C                                                                       CPL  16
      DTR=PI/180.                                                       CPL  17
      EX=COS(ANG*DTR)                                                   CPL  18
      EY=SIN(ANG*DTR)                                                   CPL  19
      HGT=0.07                                                          CPL  20
C                                                                       CPL  21
C     CALCULATE SPACE BETWEEN PLOTS                                     CPL  22
C                                                                       CPL  23
      NZ=(ZUP-ZDN)/DZ+1.00001                                           CPL  24
      PIN=VP(YIN)                                                       CPL  25
      TY=NZ*PIN                                                         CPL  26
      SPACE=(10.-TY)/(NZ+1)                                             CPL  27
      IF (SPACE.GT.0.) GO TO 5                                          CPL  28
      WRITE (IPRNT,75)                                                  CPL  29
      RETURN                                                            CPL  30
    5 CONTINUE                                                          CPL  31
C                                                                       CPL  32
C     GET COORDINATES                                                   CPL  33
C                                                                       CPL  34
      NY1=NY-1                                                          CPL  35
      DELI=YIN/NY1                                                      CPL  36
      DELU=(YMAX-YMIN)/NY1                                              CPL  37
      NX=(XMAX-XMIN)/DELU+2.00001                                       CPL  38
      IF (NX.GE.3) GO TO 10                                             CPL  39
      WRITE (IPRNT,80)                                                  CPL  40
      RETURN                                                            CPL  41
   10 NX1=NX-1                                                          CPL  42
      XIN=DELI*NX1                                                      CPL  43
      DO 15 I=1,NX                                                      CPL  44
   15 X(I)=XMIN+(I-1)*DELU                                              CPL  45
      DO 20 I=1,NY                                                      CPL  46
   20 Y(I)=YMIN+(I-1)*DELU                                              CPL  47
C                                                                       CPL  48
C     DEFINE SCALE IN UNITS PER INCH                                    CPL  49
C                                                                       CPL  50
      SCALE=DELU/DELI                                                   CPL  51
C                                                                       CPL  52
C     FIND NORMALIZATION FACTOR FOR CURRENT                             CPL  53
C                                                                       CPL  54
      SMAX=0.                                                           CPL  55
      DO 40 K=1,NZ                                                      CPL  56
      PSPACE(3)=ZDN+(K-1)*DZ                                            CPL  57

  415 FORMAT (5X,39HFIELD 3 GREATER THAN 44 OR LESS THAN 1.)            BAD 228
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C
C     LOOP ON X AND Y
C
      DO 35 I=2,NX1
      DO 35 J=2,NY1
      PSPACE(1)=X(I)
      PSPACE(2)=Y(J)
      IF (IVOPT.NE.3) GO TO 25
      CALL INTVEL (WW,PSPACE)
      XA=WW(1)
      YA=WW(2)
      GO TO 30
   25 XA=VELOC(1,PSPACE)
      YA=VELOC(2,PSPACE)
   30 S=SQRT(XA**2+YA**2)
   35 SMAX=AMAX1(SMAX,S)
   40 CONTINUE
      SD=0.50*DELI/SMAX
C
C     INITIALIZE AND SET PEN POSITION
C
      YO=SPACE
      CALL PLOT (0.,YO,-3)
      DO 70 K=1,NZ
C
C     LOOP ON DEPTH LEVELS
C
      PSPACE(3)=ZDN+(K-1)*DZ
C
C     LABEL DEPTH LEVEL AND INDICATE X-AXIS
C
      IF (K.EQ.1) GO TO 45
      YO=PIN+SPACE
      CALL PLOT (0.0,YO,-3)
C
C     DRAW BOX
C
   45 CALL PLOT (0.,0.,3)
      PX=UP(0.,YIN)
      PY=VP(YIN)
      CALL PLOT (PX,PY,2)
      PX=UP(XIN,YIN)
      CALL PLOT (PX,PY,2)
      CALL PLOT (XIN,0.,2)
      CALL PLOT (0.,0.,2)
      XN=0.5*(XIN+PX)+0.25
      YN=0.5*(PY-HGT)
      CALL NUMBER (XN,YN,HGT,PSPACE(3),0.,0.)
      CALL SYMBOL (XIN+.25,0.,HGT,1HX,0.,1)
      CALL SYMBOL (-.25,0.,HGT,1HX,0.,1)
C
C     PLOT SYMBOL AT EACH ANCHOR POINT
      DO 50 N=1,NANC
       =ANJUNC(N)
      XAN=(PJUNC(1,L)-XMIN)/SCALE
      YAN=(PJUNC(2,L)-YMIN)/SCALE
      PYO=UP(XAN,YAN)
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      PY0=VP(YAN)                                                        CPL 115
      IF (XAN.GT.XIN.OR.XAN.LT.0.) GO TO 50                              CPL 116
      IF (YAN.GT.YIN.OR.YAN.LT.0.) GO TO 50                              CPL 117
      CALL SYMBOL (PX0,PY0,HG1,11,0.0,-1)                                CPL 118
   50 CONTINUE                                                           CPL 119
C                                                                        CPL 120
C     LOOP ON X AND Y                                                    CPL 121
C                                                                        CPL 122
      DO 65 I=2,NX1                                                      CPL 123
      DO 65 J=2,NY1                                                      CPL 124
      PSPACE(1)=X(I)                                                     CPL 125
      PSPACE(2)=Y(J)                                                     CPL 126
      IF (IVOPT.NE.3) GO TO 55                                           CPL 127
      CALL INTVEL (WW,PSPACE)                                            CPL 128
      XA=WW(1)*SD                                                        CPL 129
      YA=WW(2)*SD                                                        CPL 130
      GO TO 60                                                           CPL 131
   55 XA=VELOC(1,PSPACE)*SD                                              CPL 132
      YA=VELOC(2,PSPACE)*SD                                              CPL 133
C                                                                        CPL 134
C     DRAW ARROW                                                         CPL 135
C                                                                        CPL 136
C     CALCULATE DISTANCE FROM XMIN,YMIN TO TAIL OF ARROW (INCHES).       CPL 137
C                                                                        CPL 138
   60 XS=(X(I)-XMIN)/SCALE                                               CPL 139
      YS=(Y(J)-YMIN)/SCALE                                               CPL 140
      PX1=UP(XS,YS)                                                      CPL 141
      PY1=VP(YS)                                                         CPL 142
      CALL PLOT (PX1,PY1,3)                                              CPL 143
C                                                                        CPL 144
C     CALCULATE DISTANCE FROM XMIN,YMIN TO HEAD OF ARROW (INCHES)        CPL 145
C                                                                        CPL 146
      XE=XS+XA                                                           CPL 147
      YE=YS+YA                                                           CPL 148
      PX2=UP(XE,YE)                                                      CPL 149
      PY2=VP(YE)                                                         CPL 150
      CALL PLOT (PX2,PY2,2)                                              CPL 151
C                                                                        CPL 152
C     DRAW ARROW HEAD                                                    CPL 153
C                                                                        CPL 154
      DX=PX2-PX1                                                         CPL 155
      DY=PY2-PY1                                                         CPL 156
      ANGLE=ATAN2(DY,DX)/DTR-90.                                         CPL 157
      HGS=0.28*SQRT(DX**2+DY**2)                                         CPL 158
      CALL SYMBOL (PX2,PY2,HGS,6,ANGLE,-1)                               CPL 159
   65 CONTINUE                                                           CPL 160
   70 CONTINUE                                                           CPL 161
C                                                                        CPL 162
C     PLOT TITLE                                                         CPL 163
C                                                                        CPL 164
      YC=PIN+0.5*SPACE                                                   CPL 165
      CALL SYMBOL (0.,YC,HGT,TITLE,0.,80)                                CPL 166
C                                                                        CPL 167
C     SET ORIGIN FOR NEXT PLOT                                           CPL 168
C                                                                        CPL 169
      XC=2.*XIN                                                          CPL 170
      YC=-(NZ-1)*(PIN+SPACE)-SPACE                                       CPL 171

      GO TO 350                                                          HAD 114
```

```
          CALL PLOT (X0,Y0,-3)                                                 CPL 172
          RETURN                                                               CPL 173
C                                                                              CPL 174
175    75 FORMAT (////1X,57HTOTAL HEIGHT OF PLOT EXCEEDS 10. INCHES, PLOT NOCPL 175
         1T CREATED////)                                                       CPL 176
       80 FORMAT (///1X,88HTHE NUMBER OF GRID POINTS IN THE X DIRECTION IS LCPL 177
         1ESS THAN 3, TO CORRECT THIS INCREASE NY////)                         CPL 178
          END                                                                  CPL 179
```

```
*DECK PERPLT                                                              PER   1
      SUBROUTINE PERPLT (IVOPT,NCAB,NNODE,PCAB,PCABO,TITLE)               PER   2
      DIMENSION HED(12), NPAR(14), X(2200), Y(2200), Z(2200), TITLE(8)    PER   3
      DIMENSION PCAB(3,51,22), PCABO(3,51,22), NNODE(22)                  PER   4
      COMMON /PLT1/ KPPLT,SIZE,TH(3),IPOPT,KCPLT                          PER   5
      DATA HED/6H      ,6H      ,6H      ,6H      ,6H      ,6H      ,6H   PER   6
     1     ,6H      ,6H      ,6H      ,6H      ,6H      /                 PER   7
C     IPOPT=0 ,  NO CURRENT ONLY                                          PER   8
C     IPOPT=1 ,  DEFORMED ONLY                                            PER   9
C     IPOPT=2 ,  BOTH                                                     PER  10
C                                                                         PER  11
C     INITIALIZE                                                          PER  12
C                                                                         PER  13
      DUMMY=0.                                                            PER  14
      NELTYP=1                                                            PER  15
      NTB=10                                                              PER  16
      REWIND NTB                                                          PER  17
C                                                                         PER  18
C     PUT DEFORMED COORDINATES FROM PCAB IN X,Y,Z                         PER  19
C     PUT UNDEFORMED COORDINATES FROM PCABO IN X,Y,Z                      PER  20
C     DEFINE NUMBER OF NODAL POINTS NUMNP                                 PER  21
C     DEFINE NUMBER OF ELEMENTS NEL                                       PER  22
C                                                                         PER  23
      NEL=0                                                               PER  24
      NUMNP=0                                                             PER  25
      IF (IVOPT.EQ.0) GO TO 5                                             PER  26
      IF (IPOPT.EQ.0) GO TO 20                                            PER  27
C     DEFORMED                                                            PER  28
    5 DO 15 N=1,NCAB                                                      PER  29
      INNN=NNODE(N)                                                       PER  30
      DO 15 M=1,INNN                                                      PER  31
      NUMNP=NUMNP+1                                                       PER  32
      X(NUMNP)=PCAB(1,M,N)                                                PER  33
      Y(NUMNP)=PCAB(2,M,N)                                                PER  34
      Z(NUMNP)=PCAB(3,M,N)                                                PER  35
      IF (M.EQ.1.OR.M.EQ.INNN) GO TO 10                                   PER  36
      NUMNP=NUMNP+1                                                       PER  37
      X(NUMNP)=PCAB(1,M,N)                                                PER  38
      Y(NUMNP)=PCAB(2,M,N)                                                PER  39
      Z(NUMNP)=PCAB(3,M,N)                                                PER  40
   10 IF (M.EQ.INNN) GO TO 15                                             PER  41
      NEL=NEL+1                                                           PER  42
   15 CONTINUE                                                            PER  43
      IF (IVOPT.EQ.0) GO TO 35                                            PER  44
   20 IF (IPOPT.EQ.1) GO TO 35                                            PER  45
C     UNDEFORMED                                                          PER  46
      DO 30 N=1,NCAB                                                      PER  47
      INNN=NNODE(N)                                                       PER  48
      DO 30 M=1,INNN                                                      PER  49
      NUMNP=NUMNP+1                                                       PER  50
      X(NUMNP)=PCABO(1,M,N)                                               PER  51
      Y(NUMNP)=PCABO(2,M,N)                                               PER  52
      Z(NUMNP)=PCABO(3,M,N)                                               PER  53
      IF (M.EQ.1.OR.M.EQ.INNN) GO TO 25                                   PER  54
      NUMNP=NUMNP+1                                                       PER  55
      X(NUMNP)=PCABO(1,M,N)                                               PER  56
      Y(NUMNP)=PCABO(2,M,N)                                               PER  57
```

```
      Z(NUMNP)=PCABG(3,M,N)
   25 IF (M.EQ.INNN) GO TO 30
      NEL=NEL+1
   30 CONTINUE
   35 CONTINUE
C
C     GENERATE TAPE NT8
C
      WRITE (NT8) (HED(K),K=1,12),NUMNP,NELTYP
      WRITE (NT8) DUMMY
      WRITE (NT8) (X(K),K=1,NUMNP)
      WRITE (NT8) (Y(K),K=1,NUMNP)
      WRITE (NT8) (Z(K),K=1,NUMNP)
      WRITE (NT8) DUMMY
      END FILE NT8
      NPAR(1)=1
      NPAR(2)=NEL
      NPAR(3)=1
      NPAR(4)=1
      NPAR(5)=1
      DO 40 I=6,14
   40 NPAR(I)=0
      WRITE (NT8) (NPAR(K),K=1,14)
      WRITE (NT8) DUMMY
      WRITE (NT8) DUMMY
      WRITE (NT8) DUMMY
      WRITE (NT8) DUMMY
      DO 45 I=1,NEL
      KI=2*I-1
      KJ=KI+1
   45 WRITE (NT8) I,KI,KJ
      REWIND NT8
      CALL SSP (TITLE)
      RETURN
      END
```

```
      *DECK SSP                                                         SSP    1
            SUBROUTINE SSP (HED)                                        SSP    2
      C                                                                 SSP    3
            DIMENSION HED(8), NF(18)                                    SSP    4
            DIMENSION KEL(12), XX(6), KK(14)                            SSP    5
            DIMENSION IBIN(3), BUFF(60)                                 SSP    6
      C                                                                 SSP    7
      C                                                                 SSP    8
            COMMON A(6600)                                              SSP    9
            COMMON /PLIT/ KPPLT,SIZE,IH(3),IPOPT,KCPLT                  SSP   10
      C                                                                 SSP   11
            DATA IBIN/3,4,8/                                            SSP   12
            IR=60                                                       SSP   13
            IP=61                                                       SSP   14
      C                                                                 SSP   15
      C     ****                     *********C                         SSP   16
      C     CALL FTNBIN (1,3,IBIN)          **C                         SSP   17
      C     ****                     *********C                         SSP   18
      C                                                                 SSP   19
      C     CALL SYSTEM BINARY BLOCKING ROUTINES FOR TAPES 3 AND 4  *ONLY*  SSP   20
      C                                                                 SSP   21
      C                                                                 SSP   22
      C     READ THE DATA PORTHOLE TAPE AND SET UP FILES FOR            SSP   23
      C        TAPE3 - NODE COORDINATES                                 SSP   24
      C        TAPE4 - ELEMENT CONNECTIVITIES                           SSP   25
      C                                                                 SSP   26
            CALL PORTF (NUMNP,NELTYP,N1,N2,N3,N33,KEL)                  SSP   27
      C                                                                 SSP   28
      C                                                                 SSP   29
      C     READ MASTER CONTROL CARD                                    SSP   30
      C                                                                 SSP   31
            NVIEW=1                                                     SSP   32
            SAVSIZ=SIZE                                                 SSP   33
            IF (SIZE.LT.1.0) SIZE=10.0                                  SSP   34
            IF (SIZE.GT.30.0) SIZE=30.0                                 SSP   35
      C                                                                 SSP   36
      C     PERFORM PLOT INITIALIZATION                                 SSP   37
      C                                                                 SSP   38
      C                                                                 SSP   39
      C        SET PLOT SIZE 10 TO 30 INCHES  (WITH 10 PERCENT REDUCTION)  SSP   40
      C                                                                 SSP   41
            SIZE=SIZE/11.0                                              SSP   42
            CALL FACTOR (SIZE)                                          SSP   43
      C                                                                 SSP   44
      C        SET PEN AT LOWER PERFORATION LINE                        SSP   45
      C                                                                 SSP   46
            CALL PLOT (2.0,0.0,-3)                                      SSP   47
            CALL PLOT (0.0,0.250,-3)                                    SSP   48
      C                                                                 SSP   49
            NCOUNT=0                                                    SSP   50
      C                                                                 SSP   51
      C     LOOP ON TOTAL NUMBER OF VIEWS                               SSP   52
      C                                                                 SSP   53
            IF (NVIEW.LT.1) STOP 20                                     SSP   54
            DO 95 NV=1,NVIEW                                            SSP   55
            REWIND 3                                                    SSP   56
      C                                                                 SSP   57
```

```
C     RESTORE GLOBAL COORDINATES                                    SSP  58
C                                                                   SSP  59
      CALL READS (3,A(N1),N33)                                      SSP  60
C                                                                   SSP  61
C     READ VIEW CONTROL CARD                                         SSP  62
C                                                                   SSP  63
      NFR=1                                                         SSP  64
      XX(1)=0.                                                      SSP  65
      XX(2)=0.                                                      SSP  66
      XX(3)=0.                                                      SSP  67
      XX(4)=0.                                                      SSP  68
      XX(5)=0.                                                      SSP  69
      XX(6)=0.                                                      SSP  70
C                                                                   SSP  71
C         TEST ANGLES FOR ADMISSIBILITY                             SSP  72
C                                                                   SSP  73
      L=0                                                           SSP  74
      DO 5 K=1,3                                                    SSP  75
      IF (ABS(TH(K)).LT.360.1) GO TO 5                              SSP  76
      L=L+1                                                         SSP  77
    5 CONTINUE                                                      SSP  78
      IF (L.LT.2) GO TO 10                                          SSP  79
      WRITE (IP,100)                                                SSP  80
      STOP 21                                                       SSP  81
   10 CONTINUE                                                      SSP  82
C                                                                   SSP  83
C     DEFINE PLOT COORDINATES FOR THIS VIEW                         SSP  84
C                                                                   SSP  85
      CALL P1 (A(N1),A(N2),A(N3),NUMNP,TH,XX)                       SSP  86
C                                                                   SSP  87
C     PLOT NFR FRAMES IN THIS VIEW                                  SSP  88
C                                                                   SSP  89
      DO 90 N=1,NFR                                                 SSP  90
      REWIND 4                                                      SSP  91
C                                                                   SSP  92
C     READ FRAME DATA                                               SSP  93
C                                                                   SSP  94
      KTYPE=1                                                       SSP  95
C                                                                   SSP  96
C         BY-PASS BOUNDARY ELEMENT PLOTTING                         SSP  97
      IF (KTYPE.EQ.7) GO TO 90                                      SSP  98
C                                                                   SSP  99
C         TEST FOR ADMISSIBLE ELEMENT TYPE                          SSP 100
C                                                                   SSP 101
      IF (KTYPE.GT.0.AND.KTYPE.LE.8) GO TO 15                       SSP 102
      IF (KTYPE.EQ.12) GO TO 15                                     SSP 103
      STOP 22                                                       SSP 104
   15 CONTINUE                                                      SSP 105
C                                                                   SSP 106
C     ADVANCE ELEMENT TAPE4  TO THIS ELEMENT TYPE                   SSP 107
      DO 20 L=1,NELTYP                                              SSP 108
      K=L                                                           SSP 109
      IF (KEL(L).EQ.KTYPE) GO TO 25                                 SSP 110
   20 CONTINUE                                                      SSP 111
      STOP 23                                                       SSP 112
   25 M=K-1                                                         SSP 113
      IF (M.LT.1) GO TO 40                                          SSP 114
```

```
      DO 35 J=1,M                                                      SSP 115
      READ (4) IELTYP,NUMEL,LR2                                        SSP 116
      IF (LR2.EQ.0) GO TO 35                                           SSP 117
      DO 30 I1=1,NUMEL                                                 SSP 118
      CALL READS (4,NP,LR2)                                            SSP 119
   30 CONTINUE                                                         SSP 120
   35 CONTINUE                                                         SSP 121
   40 READ (4) IELTYP,NUMEL,LR2                                        SSP 122
      IF (IELTYP.NE.KTYPE) STOP 24                                     SSP 123
C                                                                      SSP 124
C     SHIFT PEN TO NEW ORIGIN                                          SSP 125
C                                                                      SSP 126
      CALL PLOT (3.0,0.0,-3)                                           SSP 127
      NCOUNT=NCOUNT+1                                                  SSP 128
      IF (NCOUNT.EQ.1) CALL PLOT (1.0,0.7,-3)                          SSP 129
C                                                                      SSP 130
C        READ AN ELEMENT PLOT SEQUENCE CARD                            SSP 131
C                                                                      SSP 132
      NE=0                                                             SSP 133
      KK(1)=1                                                          SSP 134
      KK(2)=NUMEL                                                      SSP 135
      DO 45 IJK=3,14                                                   SSP 136
   45 KK(IJK)=0                                                        SSP 137
      IF (KK(1).LT.1) GO TO 85                                         SSP 138
      DO 50 L=1,7                                                      SSP 139
      IF (KK(2*L).LT.1) KK(2*L)=KK(2*L-1)                              SSP 140
      IF (KK(2*L).LT.KK(2*L-1)) GO TO 55                               SSP 141
   50 CONTINUE                                                         SSP 142
      GO TO 65                                                         SSP 143
C         ELEMENT SEQUENCE NOT IN ORDER                                SSP 144
   55 WRITE (IP,105) L                                                 SSP 145
   60 CONTINUE                                                         SSP 146
      IF (KK(1).GT.0) GO TO 60                                         SSP 147
      GO TO 85                                                         SSP 148
C         CHECK FOR INCREASING SEQUENCE ELEMENT NUMBERS                SSP 149
   65 L=1                                                              SSP 150
      IF (KK(1).LE.NE) GO TO 55                                        SSP 151
      DO 70 L=2,7                                                      SSP 152
      IF (KK(2*L-1).LT.1) GO TO 70                                     SSP 153
      IF (KK(2*L-1).LE.KK(2*L-3)) GO TO 55                             SSP 154
   70 CONTINUE                                                         SSP 155
C                                                                      SSP 156
C     PLOT THE RANGE OF ELEMENTS IN SEQUENCE L                         SSP 157
C                                                                      SSP 158
      DO 80 L=1,7                                                      SSP 159
      I1=KK(2*L-1)                                                     SSP 160
      IF (I1.LT.1) GO TO 85                                            SSP 161
      I2=KK(2*L)                                                       SSP 162
      IF (I2.GT.NUMEL) STOP 25                                         SSP 163
      DO 80 M=I1,I2                                                    SSP 164
C                                                                      SSP 165
C     READ THE NODES FROM TAPE.                                        SSP 166
C                                                                      SSP 167
   75 CALL READS (4,NP,LR2)                                            SSP 168
      NE=NE+1                                                          SSP 169
      IF (M.GT.NE) GO TO 75                                            SSP 170
C                                                                      SSP 171
```

```
C     PLOT THIS ELEMENT                                                 SSP 172
C                                                                       SSP 173
C     ILINE=0 , SOLID LINE , DEFORMED                                   SSP 174
C     ILINE=5 , DASHED LINE , NO CURRENT                                SSP 175
      ILINE=0                                                           SSP 176
      IF (IPOPT.EQ.0) ILINE=5                                           SSP 177
      IF (IPOPT.EQ.2.AND.NE.GT.NUMEL/2) ILINE=5                         SSP 178
      CALL P2 (A(N1),A(N2),NP,NP(4),NP(5),NP(6),NP(9),NP(10),LR2,ILINE) SSP 179
   80 CONTINUE                                                          SSP 180
C                                                                       SSP 181
C     PLOT FRAME LABELS AND TITLE CARDS                                 SSP 182
C                                                                       SSP 183
   85 CALL P3 (HED,TH)                                                  SSP 184
C                                                                       SSP 185
   90 CONTINUE                                                          SSP 186
   95 CONTINUE                                                          SSP 187
C                                                                       SSP 188
C     CLOSE THE PLOT FILE                                               SSP 189
C                                                                       SSP 190
C                                                                       SSP 191
      TH(1)=TH(1)+90.                                                   SSP 192
      TH(2)=TH(2)+90.                                                   SSP 193
      TH(3)=TH(3)+90.                                                   SSP 194
      SIZE=SAVSIZ                                                       SSP 195
      CALL PLOT (0.0,-0.95,-3)                                          SSP 196
      RETURN                                                            SSP 197
C                                                                       SSP 198
  100 FORMAT (//23H SOLUTION TERMINATED***,/20H TWO ANGLES .GT. 360)    SSP 199
  105 FORMAT (8X,10HSEQUENCE =,I2,26H ON CARD ABOVE IS IN ERROR.)       SSP 200
      END                                                               SSP 201-
```

```
      *DECK PORTB                                                        POR   1
            SUBROUTINE PORTB (NUMNP,NELTYP,N1,N2,N3,N33,KEL)             POR   2
      C                                                                  POR   3
            DIMENSION HEDT(12), IX(19), NP(18), LOUT(12), LIN(12), NPAR(14), KPOR   4
           1EL(12), AP(18)                                               POR   5
      C                                                                  POR   6
            COMMON A(6600)                                               POR   7
      C                                                                  POR   8
            EQUIVALENCE (IX(2),NP(1),AP(1))                              POR   9
      C                                                                  POR  10
            DATA LIN/3,3,5,5,9,5,6,17,0,0,0,4/,LOUT/2,2,4,4,8,4,0,16,0,0,0,18/POR  11
            IR=60                                                        POR  12
            IP=61                                                        POR  13
      C                                                                  POR  14
      C                                                                  POR  15
            NT8=10                                                       POR  16
      C                                                                  POR  17
      C                                                                  POR  18
      C     READ AND RE-FORMAT THE PORTHOLE TAPE - NT8                   POR  19
      C                                                                  POR  20
            REWIND NT8                                                   POR  21
      C                                                                  POR  22
      C     1    HEADING AND CONTROL INFORMATION                         POR  23
            READ (NT8) (HEDT(K),K=1,12),NUMNP,NELTYP                     POR  24
      C     1                                                            POR  25
      C                                                                  POR  26
      C     2    EQUATION NUMBERS FOR RETAINED DEGREES OF FREEDOM        POR  27
            READ (NT8)                                                   POR  28
      C     2                                                            POR  29
      C                                                                  POR  30
      C     SET UP ARRAY SIZE FOR COORDINATES                            POR  31
      C                                                                  POR  32
            N1=1                                                         POR  33
            N11=NUMNP                                                    POR  34
            N2=N1+NUMNP                                                  POR  35
            N22=2*NUMNP                                                  POR  36
            N3=N2+NUMNP                                                  POR  37
            N33=3*NUMNP                                                  POR  38
            N4=N3+NUMNP                                                  POR  39
            I=LOCF(A(N4))                                                POR  40
      C                                                                  POR  41
      C     3    READ NODE COORDINATES                                   POR  42
            READ (NT8) (A(K),K=N1,N11)                                   POR  43
            READ (NT8) (A(K),K=N2,N22)                                   POR  44
            READ (NT8) (A(K),K=N3,N33)                                   POR  45
      C     3                                                            POR  46
      C                                                                  POR  47
      C     PRINT FIRST AND LAST NODE COORDINATES                        POR  48
      C                                                                  POR  49
      C                                                                  POR  50
      C                                                                  POR  51
      C     SAVE NODE COORDINATES ON TAPE 3                              POR  52
      C                                                                  POR  53
            REWIND 3                                                     POR  54
            CALL WRITES (3,A(N1),N33)                                    POR  55
      C                                                                  POR  56
      C     4    NODE TEMPERATURES                                       POR  57
```

```
      READ (NT8)                                                        POR  58
C     4                                                                 POR  59
C                                                                       POR  60
C     5    END-FILE MARK                                                POR  61
      READ (NT8) NUCM                                                   POR  62
C     5                                                                 POR  63
C                                                                       POR  64
C     USE PREVIOUS CARD  FOR RUN COMPILER                               POR  65
      IF (EOF(NT8)) 10,5                                                POR  66
    5 WRITE (IP,135)                                                    POR  67
      CALL EXIT                                                         POR  68
   10 CONTINUE                                                          POR  69
C                                                                       POR  70
C                                                                       POR  71
C     PROCESS ELEMENT DATA AND SAVE CONNECTIVITIES ON TAPE 4            POR  72
C                                                                       POR  73
      REWIND 4                                                          POR  74
C                                                                       POR  75
C                                                                       POR  76
      DO 130 M=1,NELTYP                                                 POR  77
C                                                                       POR  78
C     6    ELEMENT CONTROL PARAMETERS                                   POR  79
      READ (NT8) (NPAR(K),K=1,14)                                       POR  80
C     6                                                                 POR  81
C                                                                       POR  82
      IELTYP=NPAR(1)                                                    POR  83
      KEL(M)=IELTYP                                                     POR  84
      NUMEL=NPAR(2)                                                     POR  85
C                                                                       POR  86
      LR=LIN(IELTYP)                                                    POR  87
      LR2=LOUT(IELTYP)                                                  POR  88
C                                                                       POR  89
      WRITE (4) IELTYP,NUMEL,LR2                                        POR  90
C                                                                       POR  91
C                                                                       POR  92
      GO TO (15,25,35,40,50,55,65,70,75,85,90,95), IELTYP               POR  93
C                                                                       POR  94
C                                                                       POR  95
   15 CONTINUE                                                          POR  96
C                                                                       POR  97
C     7    MATERIAL PROPERTIES                                          POR  98
      NUMMAT=NPAR(3)                                                    POR  99
      DO 20 ISKIP=1,NUMMAT                                              POR 100
      READ (NT8)                                                        POR 101
      READ (NT6)                                                        POR 102
   20 CONTINUE                                                          POR 103
C     7                                                                 POR 104
C          SECTION PROPERTIES                                           POR 105
C                                                                       POR 106
      READ (NT8)                                                        POR 107
C                                                                       POR 108
C     8    LOAD MULTIPLIERS                                             POR 109
      READ (NT8)                                                        POR 110
C                                                                       POR 111
C                                                                       POR 112
      GO TO 100                                                         POR 113
C                                                                       POR 114
```

```
      25 CONTINUE                                                       POR 115
         NUMFIX=NPAR(4)                                                 POR 116
         NUMMAT=NPAR(3)                                                 POR 117
C              MATERIAL PROPERTIES                                      POR 118
C        9                                                              POR 119
         DO 30 ISKIP=1,NUMMAT                                           POR 120
         READ (NT8)                                                     POR 121
C        9                                                              POR 122
C        10                                                             POR 123
         READ (NT8)                                                     POR 124
      30 CONTINUE                                                       POR 125
C        10                                                             POR 126
C        11                                                             POR 127
         READ (NT8)                                                     POR 128
C        11                                                             POR 129
C        12                                                             POR 130
         IF (NUMFIX.GT.0) READ (NT8)                                    POR 131
C        12                                                             POR 132
C                                                                       POR 133
         READ (NT8)                                                     POR 134
         GO TO 100                                                      POR 135
C                                                                       POR 136
      35 CONTINUE                                                       POR 137
      40 CONTINUE                                                       POR 138
C                                                                       POR 139
         MAT=NPAR(3)                                                    POR 140
C                                                                       POR 141
         DO 45 ISKIP=1,MAT                                              POR 142
C        13                                                             POR 143
         READ (NT8)                                                     POR 144
C        13                                                             POR 145
C        14                                                             POR 146
         READ (NT8)                                                     POR 147
C        14                                                             POR 148
      45 CONTINUE                                                       POR 149
C        15                                                             POR 150
         READ (NT8)                                                     POR 151
C        15                                                             POR 152
         GO TO 100                                                      POR 153
C                                                                       POR 154
      50 CONTINUE                                                       POR 155
         NLD=NPAR(4)                                                    POR 156
C        16                                                             POR 157
         READ (NT8)                                                     POR 158
C        16                                                             POR 159
C        17                                                             POR 160
         IF (NLD.GT.0) READ (NT8)                                       POR 161
C        17                                                             POR 162
C        18                                                             POR 163
         READ (NT8)                                                     POR 164
C        19                                                             POR 165
C                                                                       POR 166
         GO TO 100                                                      POR 167
C                                                                       POR 168
      55 CONTINUE                                                       POR 169
C        19                                                             POR 170
C              MATERIAL PROPERTIES                                      POR 171
```

```
      NUMMAT=NPAR(3)                                                POR 172
      DO 60 ISKIP=1,NUMMAT                                          POR 173
      READ (NT8)                                                    POR 174
C     19                                                            POR 175
C     20                                                            POR 176
      READ (NT8)                                                    POR 177
   60 CONTINUE                                                      POR 178
C     20                                                            POR 179
C                                                                   POR 180
C            LOAD MULTIPLIERS                                       POR 181
      READ (NT8)                                                    POR 182
      GO TO 100                                                     POR 183
C                                                                   POR 184
   65 CONTINUE                                                      POR 185
C     21                                                            POR 186
      READ (NT8)                                                    POR 187
C     21                                                            POR 188
C                                                                   POR 189
      GO TO 100                                                     POR 190
C                                                                   POR 191
   70 CONTINUE                                                      POR 192
      NLD=NPAR(4)                                                   POR 193
C     22                                                            POR 194
      READ (NT8)                                                    POR 195
C     22                                                            POR 196
C     23                                                            POR 197
      IF (NLD.GT.0) READ (NT8)                                      POR 198
C     23                                                            POR 199
C     24                                                            POR 200
      READ (NT8)                                                    POR 201
C     24                                                            POR 202
C                                                                   POR 203
      GO TO 100                                                     POR 204
C                                                                   POR 205
   75 CONTINUE                                                      POR 206
C                                                                   POR 207
   80 WRITE (IP,140) IELTYP                                         POR 208
      STOP                                                          POR 209
C                                                                   POR 210
   85 GO TO 80                                                      POR 211
C                                                                   POR 212
   90 GO TO 80                                                      POR 213
C                                                                   POR 214
C     SKIP PIPE PROPERTIES, SECTIONS, BRANCH PT NODES, MULTIPLIERS  POR 215
C                                                                   POR 216
   95 NBPN=NPAR(6)                                                  POR 217
      READ (NT8)                                                    POR 218
      READ (NT8)                                                    POR 219
      IF (NBPN.GT.0) READ (NT8)                                     POR 220
      READ (NT8)                                                    POR 221
C                                                                   POR 222
C     * * * * * * * * * * * * * * * * * *                           POR 223
C                                                                   POR 224
  100 CONTINUE                                                      POR 225
C                                                                   POR 226
C     READ ALL ELEMENTS OF THIS TYPE                                POR 227
C                                                                   POR 228
```

```
      LRR2=LR2                                                          POR 229
      IF (IELTYP.EQ.12) LRR2=3                                          POR 230
      DO 125 K=1,NUMEL                                                  POR 231
C                                                                       POR 232
      CALL READS (NT8,IX,LR)                                            POR 233
C                                                                       POR 234
C     BY-PASS THE BOUNDARY ELEMNTS                                      POR 235
      IF (IELTYP.EQ.7) GO TO 120                                        POR 236
C                                                                       POR 237
C     CHECK FOR SEQUENTIAL INPUT ORDER                                  POR 238
      IF (IX(1).EQ.K) GO TO 105                                         POR 239
      WRITE (IP,145) IX(1),K,I                                          POR 240
      CALL EXIT                                                         POR 241
C                                                                       POR 242
  105 CONTINUE                                                          POR 243
C                                                                       POR 244
C     TEST FOR FOURTH NODE ZERO                                         POR 245
      IF (LR2.NE.4) GO TO 110                                           POR 246
      IF (NP(4).LT.1) NP(4)=NP(3)                                       POR 247
C                                                                       POR 248
  110 IF (IELTYP.NE.12) GO TO 115                                       POR 249
C                                                                       POR 250
C     READ RADIUS,KODE,X3P (BEND) OR JUNK (TANGENT)                     POR 251
C                                                                       POR 252
      READ (NT8) AP(4),NP(5),AP(6),AP(7),AP(8)                          POR 253
      IF (NP(1).EQ.1) GO TO 115                                         POR 254
C                                                                       POR 255
C     BEND.  READ THETA AND DC ARRAY                                    POR 256
C                                                                       POR 257
      READ (NT8) (AP(IJL),IJL=9,18)                                     POR 258
C                                                                       POR 259
C     PIPE TAPE SAVE FORMATS (TAPE4)                                    POR 260
C     TANGENT  -  1,NI,NJ,XLN,JUNK(5)-JUNK(14)                          POR 261
C     BEND     -  2,NI,NJ,RADIUS,KODE,X3P,THETA,DC(1,1)-DC(3,3)         POR 262
C                                                                       POR 263
  115 CALL WRITES (4,NP,LR2)                                            POR 264
C                                                                       POR 265
C     PRINT FIRST AND LAST ELEMENT CONNECTIONS                          POR 266
C                                                                       POR 267
  120 CONTINUE                                                          POR 268
C                                                                       POR 269
  125 CONTINUE                                                          POR 270
C                                                                       POR 271
  130 CONTINUE                                                          POR 272
C                                                                       POR 273
C                                                                       POR 274
      RETURN                                                            POR 275
C                                                                       POR 276
  135 FORMAT (////23H SOLUTION TERMINATED***,/39H NO END-OF-FILE ENCOUNTPOR 277
     1ERED ON TAPE NT8.)                                                POR 278
  140 FORMAT (//26H **ERROR... ELEMENT TYPE (,I2,23H) ENCOUNTERED ON TAPPOR 279
     1E8.,/1X)                                                          POR 280
  145 FORMAT (//43H **ERROR... ELEMENTS ON TAPE8 ARE NOT SEQUENTIAL,5X,3POR 281
     1I5)                                                               POR 282
      END                                                               POR 283-
```

```
          *DECK WRITES                                                   WRI    1
                SUBROUTINE WRITES (ITAPE,A,LREC)                         WRI    2
                DIMENSION A(LREC)                                        WRI    3
                WRITE (ITAPE) A                                          WRI    4
                RETURN                                                   WRI    5
                END                                                      WRI    6
```

```
      *DECK READS                                               REA    1
            SUBROUTINE READS (ITAPE,A,LREC)                     REA    2
            DIMENSION A(LREC)                                   REA    3
            READ (ITAPE) A                                      REA    4
            RETURN                                              REA    5
            END                                                 REA    6-
```

```
*DECK P1
      SUBROUTINE P1 (U,V,W,NUMNP,TH,XM)
C
C     PLOT VIEW INITIALIZATION PROGRAM
C
      DIMENSION U(1), V(1), W(1), TH(1), XM(1)
C
      COMMON /MESH/ XX(12),YY(12),XLEN,YLEN,ALEN,EX(3),EY(3),XMIN,YMIN
C
      DATA RAD/0.01745329254/
C
C     CONVERT COORDINATES TO A TWO-DIMENSIONAL PROJECTION
C
      DO 5 I=1,3
      EY(I)=SIN(TH(I)*RAD)
      EX(I)=COS(TH(I)*RAD)
      IF (TH(I).LE.350.) GO TO 5
      EX(I)=0.
      EY(I)=0.
    5 CONTINUE
C
      DO 10 I=1,NUMNP
      TEMP=U(I)*EY(1)+V(I)*EY(2)+W(I)*EY(3)
      U(I)=U(I)*EX(1)+V(I)*EX(2)+W(I)*EX(3)
      V(I)=TEMP
   10 CONTINUE
C
C     CONVERT MAX/MIN CONTROL DIMENSIONS TO THE PLOT SYSTEM (U,V)
C
      DUM=0.0
      DO 15 K=1,6
   15 DUM=DUM+ABS(XM(K))
      IF (DUM.LT.0.001) GO TO 25
C
      D1=XM(1)*EX(1)
      D2=XM(2)*EX(1)
      D3=XM(1)*EY(1)
      D4=XM(2)*EY(1)
      D5=XM(3)*EX(2)
      D6=XM(4)*EX(2)
      D7=XM(3)*EY(2)
      D8=XM(4)*EY(2)
      D9=XM(5)*EX(3)
      D10=XM(6)*EX(3)
      D11=XM(5)*EY(3)
      D12=XM(6)*EY(3)
C
C     U - VALUES FOR MAX/MIN CONTROL POINTS
C
      W(1)=D1+D5+D9
      W(2)=D1+D6+D9
      W(3)=D1+D5+D10
      W(4)=D1+D6+D10
      W(5)=D2+D5+D9
      W(6)=D2+D6+D9
      W(7)=D2+D5+D10
      W(8)=D2+D6+D10
```

```
C     VALUES FOR MAX/MIN CONTROL POINTS
C
      W(9)=D3*D7*D11
      W(10)=D3*D8*D11
      W(11)=D3*D7*D12
      W(12)=D3*D8*D12
      W(13)=D4*D7*D11
      W(14)=D4*D8*D11
      W(15)=D4*D7*D12
      W(16)=D4*D8*D12
C
C     FIND MAX-MIN DIMENSIONS IN THE CONTROLLED SCALE DIMENSIONS
C
      XMIN=W(1)
      YMIN=W(9)
      XMAX=W(1)
      YMAX=W(9)
      DO 20 I=2,8
      IF (XMIN.GT.W(I)) XMIN=W(I)
      IF (W(I).GT.XMAX) XMAX=W(I)
      IF (YMIN.GT.W(I+8)) YMIN=W(I+8)
      IF (W(I+8).GT.YMAX) YMAX=W(I+8)
   20 CONTINUE
      GO TO 35
C
C     FIND MAX-MIN DIMENSIONS FROM NODAL POINT ARRAY (NO USER CONTROL)
C
   25 XMIN=U(1)
      YMIN=V(1)
      XMAX=U(1)
      YMAX=V(1)
      DO 30 I=2,NUMNP
      IF (XMIN.GT.U(I)) XMIN=U(I)
      IF (U(I).GT.XMAX) XMAX=U(I)
      IF (YMIN.GT.V(I)) YMIN=V(I)
      IF (V(I).GT.YMAX) YMAX=V(I)
   30 CONTINUE
C
C     SHIFT PLOT ANGLES FOR SYMBOL PLOT OF GLOBAL AXES
C
   35 DO 40 I=1,3
      TH(I)=TH(I)-90.0
   40 CONTINUE
C
C     FIND PROPER HORIZONTAL SCALE
C
      YLEN=(YMAX-YMIN)/10.0
      IF (YLEN.GT.0.0) GO TO 45
      XLEN=(XMAX-XMIN)/10.0
      ALEN=10.0
      GO TO 50
   45 ALEN=(XMAX-XMIN)/YLEN
      XLEN=YLEN
      IF (ALEN.LT.30.0) GO TO 50
      XLEN=(XMAX-XMIN)/30.0
      YLEN=XLEN
```

... ... ATCHES   FOR 57

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3 of 3

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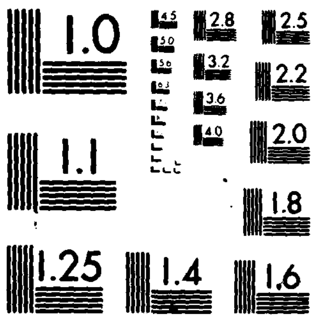

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

```
      ALEN=30.0                                                          P1   115
C                                                                        P1   116
C     SET SCALE PARAMETERS                                               P1   117
C                                                                        P1   118
   50 CONTINUE                                                           P1   119
      XX(11)=0.0                                                         P1   120
      XX(12)=XLEN                                                        P1   121
      YY(11)=0.0                                                         P1   122
      YY(12)=YLEN                                                        P1   123
C                                                                        P1   124
C     CONVERT PLOT ORDINATES TO RELATIVE VALUES                          P1   125
C                                                                        P1   126
      DO 55 I=1,NUMNP                                                    P1   127
      U(I)=U(I)-XMIN                                                     P1   128
      V(I)=V(I)-YMIN                                                     P1   129
   55 CONTINUE                                                           P1   130
C                                                                        P1   131
      RETURN                                                             P1   132
      END                                                                P1   133
```

CARD NR.	SEVERITY	DETAILS	DIAGNOSIS OF PROBLEM
36	I	XM	ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
38	I	XM	ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
39	I	XM	ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
40	I	XM	ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
41	I	XM	ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
42	I	XM	ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
43	I	XM	ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
44	I	XM	ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
45	I	XM	ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
46	I	XM	ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
51	I	W	ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
52	I	W	ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
53	I	W	ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
54	I	W	ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
55	I	W	ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
56	I	W	ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
57	I	W	ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
61	I	W	ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
62	I	W	ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
63	I	W	ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
64	I	W	ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
65	I	W	ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
66	I	W	ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
67	I	W	ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
68	I	W	ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
73	I	W	ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
75	I	W	ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.

```
*DECK P2
      SUBROUTINE P2 (U,V,NP,RADIUS,KODE,X3P,THETA,DC,NODES,ILINE)
C
C     THIS SUBROUTINE PLOTS A 2, 4, 8, OR 16-NODE ELEMENT
C
      DIMENSION U(1), V(1), NP(1), IT(9)
      DIMENSION DC(3,3), X3P(3)
C
      COMMON /MESH/ XX(12),YY(12),XLEN,YLEN,ALEN,EX(3),EY(3),XMIN,YMIN
C
      DATA IT/9,2,10,3,11,4,12,1,9/
      DATA RAD2/0.03490658/
C
C     DETERMINE THE TYPE OF ELEMENT TO BE PLOTTED
C
      IF (NODES.EQ.16) GO TO 40
      IF (NODES.EQ.8) GO TO 25
      IF (NODES.EQ.4) GO TO 15
      N=0
      IM=0
      IN=0
      IN=ILINE
      IF (NODES.NE.18) GO TO 5
      IF (NP(1).EQ.2) GO TO 60
      N=1
      IM=1
      IM=1
C
C     TWO NODE ELEMENT
C
    5 DO 10 M=1,2
      N=N+1
      J=NP(N)
      XX(M)=U(J)
   10 YY(M)=V(J)
      XX(3)=XX(11)
      XX(4)=XX(12)
      YY(3)=YY(11)
      YY(4)=YY(12)
C
      CALL LINE (XX,YY,2,1,IM,IN)
      RETURN
C
C     FOUR NODE ELEMENT (QUADRILATERAL OR TRIANGLE)
C
   15 CONTINUE
      DO 20 M=1,4
      J=NP(M)
      XX(M)=U(J)
   20 YY(M)=V(J)
      XX(5)=XX(1)
      YY(5)=YY(1)
      XX(6)=XX(11)
      XX(7)=XX(12)
      YY(6)=YY(11)
      YY(7)=YY(12)
C
```

```
      CALL LINE (XX,YY,5,1,0,0)
      RETURN
C
C     EIGHT NODE ELEMENT (BRICK OR WEDGE)
C
   25 CONTINUE
      DO 30 M=1,4
      J=NP(M)
      XX(M)=U(J)
   30 YY(M)=V(J)
C
      DO 35 M=5,8
      JJ=13-M
      J=NP(JJ)
      XX(M)=U(J)
   35 YY(M)=V(J)
C
      XX(9)=XX(1)
      YY(9)=YY(1)
      XX(10)=XX(4)
      YY(10)=YY(4)
C
      CALL LINE (XX,YY,10,1,0,0)
      XX(9)=XX(5)
      YY(9)=YY(5)
      XX(10)=XX(8)
      YY(10)=YY(8)
      CALL LINE (XX(9),YY(9),2,1,0,0)
      XX(9)=XX(6)
      YY(9)=YY(6)
      XX(10)=XX(3)
      YY(10)=YY(3)
      CALL LINE (XX(9),YY(9),2,1,0,0)
      XX(9)=XX(2)
      YY(9)=YY(2)
      XX(10)=XX(7)
      YY(10)=YY(7)
      CALL LINE (XX(9),YY(9),2,1,0,0)
C
      RETURN
C
C     SIXTEEN NODE ELEMENT (THICK SHELL)
C
   40 CONTINUE
C
C        TOP AND BOTTOM (USING SYMBOL FOR MID-NODES)
      INC=0
      DO 50 I=1,2
      IF (I.EQ.2) INC=4
      DO 45 M=1,9
      JJ=IT(M)+INC
      J=NP(JJ)
      XX(M+1)=U(J)
   45 YY(M+1)=V(J)
   50 CALL LINE (XX(2),YY(2),9,1,2,1)
C
C        EDGES
```

```
      C                                                                P2  115
            DO 55 I=1,4                                                P2  116
            J=NP(I)                                                    P2  117
            K=NP(I+4)                                                  P2  118
            XX(9)=U(J)                                                 P2  119
            YY(9)=V(J)                                                 P2  120
            XX(10)=U(K)                                                P2  121
            YY(10)=V(K)                                                P2  122
         55 CALL LINE (XX(9),YY(9),2,1,0,0)                            P2  123
      C                                                                P2  124
            RETURN                                                     P2  125
      C                                                                P2  126
      C     BEND (PIPE ELEMENT)                                        P2  127
      C                                                                P2  128
         60 NSEG=THETA/RAD2                                            P2  129
            IF (NSEG.LT.1) NSEG=1                                      P2  130
            J=NP(2)                                                    P2  131
            XX(2)=U(J)                                                 P2  132
            YY(2)=V(J)                                                 P2  133
            XX(3)=XX(11)                                               P2  134
            XX(4)=XX(12)                                               P2  135
            YY(3)=YY(11)                                               P2  136
            YY(4)=YY(12)                                               P2  137
            THTA=0.                                                    P2  138
            EDC11=EX(1)*DC(1,1)+EX(2)*DC(2,1)+EX(3)*DC(3,1)            P2  139
            EDC12=EX(1)*DC(1,2)+EX(2)*DC(2,2)+EX(3)*DC(3,2)            P2  140
            EDC21=EY(1)*DC(1,1)+EY(2)*DC(2,1)+EY(3)*DC(3,1)            P2  141
            EDC22=EY(1)*DC(1,2)+EY(2)*DC(2,2)+EY(3)*DC(3,2)            P2  142
            CALL LINE (XX(2),YY(2),1,1,-1,1)                           P2  143
            RTERM=RADIUS                                               P2  144
            IF (KODE.EQ.1) RTERM=RADIUS*TAN(0.5*THETA)                 P2  145
            UCOR=(EX(1)*(X3P(1)-DC(1,KODE)*RTERM)+EX(2)*(X3P(2)-DC(2,KODE)*RTEP2  146
           1RM)+EX(3)*(X3P(3)-DC(3,KODE)*RTERM))-XMIN                  P2  147
            VCOR=(EY(1)*(X3P(1)-DC(1,KODE)*RTERM)+EY(2)*(X3P(2)-DC(2,KODE)*RTEP2  148
           1RM)+EY(3)*(X3P(3)-DC(3,KODE)*RTERM))-YMIN                  P2  149
            DO 70 I=1,NSEG                                             P2  150
            XX(1)=XX(2)                                                P2  151
            YY(1)=YY(2)                                                P2  152
            THTA=THTA+RAD2                                             P2  153
            X=RADIUS*SIN(THTA)                                         P2  154
            Y=RADIUS*(1.-COS(THTA))                                    P2  155
            XX(2)=EDC11*X+EDC12*Y+UCOR                                 P2  156
            YY(2)=EDC21*X+EDC22*Y+VCOR                                 P2  157
            IF (I.LT.NSEG) GO TO 65                                    P2  158
            J=NP(3)                                                    P2  159
            XX(2)=U(J)                                                 P2  160
            YY(2)=V(J)                                                 P2  161
         65 CALL LINE (XX,YY,2,1,0,0)                                  P2  162
         70 CONTINUE                                                   P2  163
            CALL LINE (XX(2),YY(2),1,1,-1,1)                           P2  164
            RETURN                                                     P2  165
      C                                                                P2  166
            END                                                        P2  167-
```

```
CARD NR. SEVERITY  DETAILS   DIAGNOSIS OF PROBLEM

   131     I        NP       ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
   159     I        NP       ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
```

```
      *DECK P3
            SUBROUTINE P3 (HED,TH)
      C
      C     THIS ROUTINE COMPLETES THE PLOT FRAME
      C
            DIMENSION HED(1), TH(1), H(3)
      C
            COMMON /MESH/ XX(12),YY(12),XLEN,YLEN,ALEN,EX(3),EY(3)
      C
            DATA H/1HX,1HY,1HZ/
            IR=60
            IP=61
      C
      C     PLOT TITLE AND AXES
      C
            CALL SYMBOL (0.0,-.3,0.14,HED(1),0.0,80)
            CALL PLOT (-1.5,1.5,-3)
            DO 5 I=1,3
            IF (TH(I).GT.270.) GO TO 5
            CALL SYMBOL (.5*EX(I),.5*EY(I),1.0,13,TH(I),-1)
            CALL SYMBOL (EX(I),EY(I),0.1,6,TH(I),-1)
            CALL SYMBOL (1.2*EX(I)-.075,1.2*EY(I)-.075,.15,H(I),0.0,1)
          5 CONTINUE
      C
      C     ADVANCE PAPER TO NEXT FRAME
      C
            CALL PLOT (1.5,-1.5,-3)
            CALL PLOT (ALEN+7.0,0.0,-3)
      C
            RETURN
            END
```

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